

GAO

United States General Accounting Office

Report to the Chairman, Subcommittee on
Defense, Committee on Appropriations,
House of Representatives

July 1989

ATTACK WARNING

Better Management Required to Resolve NORAD Integration Deficiencies



19980513 237

DISTRIBUTION STATEMENT A

Approved for public release
Distribution Unlimited

PLEASE RETURN TO:

BMD TECHNICAL INFORMATION CENTER
BALLISTIC MISSILE DEFENSE ORGANIZATION
7100 DEFENSE PENTAGON
WASHINGTON D.C. 20301-7100

U01923

Accession Number: 1923

Publication Date: Jul 07, 1989

Title: Attack Warning: Better Management Required to Resolve NORAD Integration Deficiencies

Personal Author: Malloy, J.E.; Hernandez, M.R.; McGinty, S.L.; Appel, C.J.

Corporate Author Or Publisher: U.S. General Accounting Office, GAO, Washington, DC 20548 Report Number: GAO/IMTEC-89-26

Descriptors, Keywords: Surveillance Warning Communication Attack Methodology Evaluation Logistics Congress Development NORAD ITW/AA C3 TW/AA Cost Management Computer Network

Pages: 067

Cataloged Date: Sep 11, 1989

Document Type: HC

Number of Copies In Library: 000002

Record ID: 20796

Information Management and
Technology Division

B-209661

July 7, 1989

The Honorable John P. Murtha
Chairman, Subcommittee on Defense
Committee on Appropriations
House of Representatives

Dear Mr. Chairman:

At the request of the former Chairman and as agreed with your office, we reviewed the Air Force's efforts to modernize the nation's Integrated Tactical Warning and Attack Assessment System's data processing and communications capabilities. Our review focused on the Air Force's effectiveness in integrating new systems under development that are crucial to the North American Aerospace Defense Command's mission to provide timely strategic surveillance and attack warning information to United States and Canadian leaders. Although management structures have been established to direct and control systems integration activities, we found that timely decisions are not being made, resulting in systems that may not be effectively integrated, are over budget, and are behind schedule.

We have also issued reports on two of the modernization programs—the Communications System Segment Replacement (GAO/IMTEC-89-1, Nov. 30, 1988) and the Space Defense Operations Center 4 (GAO/IMTEC-89-18, Apr. 20, 1989). They describe additional managerial and technical deficiencies that must be overcome before the systems can provide the operational capability required by the Air Force.

We are sending copies of this report to the Chairmen, House and Senate Committees on Armed Services; the Chairman, Senate Committee on Appropriations; the Director, Office of Management and Budget; the Secretary of Defense; the Secretary of the Air Force; and other interested parties. Copies will also be made available to others upon request.

This report was prepared under the direction of Samuel W. Bowlin, Director for Defense and Security Information Systems. Other major contributors are listed in appendix IV.

Sincerely yours,



Ralph V. Carbone
Assistant Comptroller General

DTIC QUALITY INSPECTED 4

Executive Summary

Purpose

The North American Aerospace Defense Command (NORAD), a binational command, is responsible for notifying United States and Canadian leaders that North America is under air or missile attack. The former Chairman, Subcommittee on Defense, House Committee on Appropriations, asked GAO to evaluate the Air Force's efforts to modernize the data processing and communications components of NORAD's warning and attack assessment system. Accordingly, GAO evaluated how effectively the Air Force was developing five modernization programs, and how it was resolving development problems within and among the programs.

Background

The command and control center for NORAD is the Cheyenne Mountain Air Force Station, which houses data processing and communications equipment supporting the tactical warning and attack assessment mission. The equipment and subsystems in Cheyenne Mountain form the nucleus of the integrated Tactical Warning and Attack Assessment (TW/AA) system.

The Cheyenne Mountain complex became operational in 1966. In November 1979 and June 1980, three false attack indications were generated by the TW/AA system. These incidents attracted adverse publicity and nearly caused an international crisis.

The Air Force Chief of Staff subsequently commissioned a special management review of U.S. Air Force support to the TW/AA system. The review found that TW/AA subsystems were not recognized or managed by the Air Force as a single system. This led to (1) divided approaches on how subsystems were acquired, integrated, and managed, and (2) lack of end-to-end direction for operations concepts, doctrine, and procedures. In response to these findings, the Joint Chiefs of Staff established an executive management structure for the TW/AA system that placed the Air Force Chief of Staff in charge of the system's technical integration.¹

In 1981 the Air Force began developing five modernization programs to replace or upgrade computer subsystems at the Cheyenne Mountain complex. These programs are still under development, at an estimated total cost exceeding \$1.3 billion.

¹Technical integration implies maintaining technical integrity (i.e., confidence that a given input will result in a known, desired output) not only of individual subsystems, but of the entire system.

Results in Brief

The Air Force plans to spend more than \$775 million through fiscal year 1989 to modernize and replace the computer and communications subsystems at NORAD's Cheyenne Mountain complex. After almost 8 years of development, no phase of any of the five modernization programs is operational. The Air Force estimates that it will need at least an additional \$535 million and 5 more years to complete the modernization it initially planned to complete by 1987.

Long-standing, serious integration problems, which could disrupt the ability of the various modernization initiatives to work together effectively to accomplish NORAD's mission, remain unresolved. The process for resolving development and integration problems is cumbersome, lengthy, and ineffective, and development problems have been continually deferred to future program phases rather than being solved. Moreover, accountability has been diffused across a large, multicommand management structure and further diluted by frequent turnover in key command and management positions.

No single, accountable manager below the Air Force Chief of Staff has authority for the total TW/AA system. Without a single manager at the command level, the responsible Air Force commands have been managing development and integration by consensus, through a proliferation of boards and working groups. Instead of streamlining the procurement and integration processes, the effect has been to expand the structure and divide responsibility.

The net effect of a cumbersome structure, divided responsibility, poor management continuity, and deferred problem resolution has been to deliver subsystems that do not meet specifications and may not be effectively integrated without additional, costly changes.

Principal Findings

The Air Force recognized the need to manage the TW/AA system as a single entity as early as 1977 but, despite several reports over the years on the need for a single manager, the Air Force has established a large, complex support structure, spanning six commands for integrating and managing the system. Successful integration of the TW/AA subsystems now depends on this organization's ability to identify and resolve critical problems through consensus among the commands and over 200 directorates, boards, and working groups within them.

Critical integration problems exist among the five modernization programs, such as subsystems being built to differing communications standards and attack scenarios. These problems and 46 others have been addressed through a cumbersome resolution process since 1984; the most serious problems remain unresolved. Development activity has continued in the face of these known, unresolved problems, and potential solutions will become more complex, harder to implement, and more costly.

Exacerbating the problems of a cumbersome, ineffective management structure is the lack of management continuity across the modernization programs. Defense recognizes the need for continuity in program management; however, every commander, vice commander, key directorate head, and program manager, with two exceptions, has changed several times during the lives of these programs.

Within this environment of continually changing, multiple managers, the Air Force has adopted the practice of deferring, rather than solving, problems that occurred during development of the five modernization programs. For example, the subsystem built under one of the programs will not work with other NORAD subsystems because it was designed to a wiring standard that is not compatible with equipment currently in Cheyenne Mountain. The Air Force has been aware since 1984 that Cheyenne Mountain wiring is incompatible, but has not resolved the problem. In another program, the Air Force deferred fundamental technical problems from one phase of the program to the next for over 3 years. Believing that fundamental problems would somehow be taken care of in later phases of the program, the Air Force ultimately accepted a part of the subsystem that cost \$235 million, was more than 3 years late, and could not meet its originally required operational capability.

Recommendations

To encourage effective management of the TW/AA system, GAO recommends that the Secretary of Defense restructure the roles and responsibilities of the key managers within the TW/AA executive management structure, designating a single manager, at a level below the Air Force Chief of Staff, with the responsibility, authority, and accountability to develop and maintain the TW/AA system as a whole. The Secretary should further ensure that the designated system manager has control over the budgetary and management resources necessary to carry out these responsibilities. GAO is also making other recommendations to the Secretary (see ch. 4).

Agency Comments

The Department of Defense concurred or partially concurred with all of the report's findings and recommendations. Defense updated the TW/AA Program Management Directive on January 12, 1989, to recognize the many commands involved in the system's life cycle and to assign responsibilities to these organizations. Defense states that under the Program Management Directive the system executive manager—Commander, Air Force Space Command—is the single manager below the Air Force Chief of Staff. As such, the Commander has been assigned responsibility, authority, and accountability for the TW/AA system, from requirements through acquisition oversight to operations and maintenance.

GAO believes that Defense has taken positive steps to improve the management of the troubled TW/AA modernization. These steps include clearly designating a single manager and stating its intention to streamline, consolidate, and eliminate, as necessary, the large complex support structure encompassing over 200 directorates, boards, panels, and working groups. However, GAO believes that constant management attention will be needed to ensure that the problems that have been inherent in the modernization programs to date are resolved. An evaluation of Defense's comments on the report (see app. III) is included in chapter 4.

Contents

Executive Summary	2
<hr/>	
Chapter 1	8
Introduction	
Past Problems Have Shaped Today's TW/ AA	9
Management and Modernization	
Cost Estimates for the Five TW/AA Modernization	18
Programs	
Congress Directed Increased Defense Oversight	19
Objectives, Scope, and Methodology	19
<hr/>	
Chapter 2	22
Integration Problem	
Resolution Is	
Cumbersome, Lengthy,	
and Ineffective	
Cumbersome Structure Divides Responsibility; Places	23
Accountability Above Those Needing to Act	
Other Integration Problems Faced Similar Resolution	27
Hurdles	
<hr/>	
Chapter 3	29
Accountability in	
Program Management	
Is Lacking	
Management Structure, Turnover Stymie Program	29
Management Continuity Goal	
Deferring Critical Decisions Diffuses Accountability	31
<hr/>	
Chapter 4	34
Conclusions and	
Recommendations	
Recommendations to the Secretary of Defense	35
Agency Comments and Our Evaluation	35
<hr/>	
Appendixes	38
Appendix I: Air Force Command Life Cycle	
Responsibilities for the TW/AA System and Its Five	
Cheyenne Mountain Modernization Programs	
Appendix II: The Five TW/AA Modernization Programs	45
Appendix III: Comments From the Department of Defense	47
Appendix IV: Major Contributors to This Report	67
<hr/>	
Tables	
Table 1.1:Estimated Expenditures and Future Costs for	
the Five TW/AA Modernization Programs	
Table 3.1: Program Management Stability	31

Figures

Figure 1.1: NORAD TW/AA System	9
Figure 1.2: TW/AA Organizational Structure	14
Figure 1.3: Proposed NORAD TW/AA System	18

Abbreviations

CCPDS-R	Command Center Processing Display System Replacement
CSS-R	Communications System Segment Replacement
GAO	General Accounting Office
GS	Granite Sentry
IMTEC	Information Management and Technology Division
NORAD	North American Aerospace Defense Command
SPADOC 4	Space Defense Operations Center 4
SCIS	Survivable Communications Integration System
TW/AA	Tactical Warning and Attack Assessment

Introduction

The North American Aerospace Defense Command (NORAD) is a binational United States and Canadian military command for defense of the North American continent. U.S. and Canadian leaders rely on NORAD to, among other things, provide surveillance of the North American aerospace to warn and assess the extent of bomber and missile attacks. The United States supports NORAD through the U.S. Space Command, whose mission is to (1) provide warning and assessment of any air- or space-based attacks on the continental United States, (2) plan for defense against ballistic missiles, and (3) operate and protect U.S. space systems and confront enemy space systems during war.

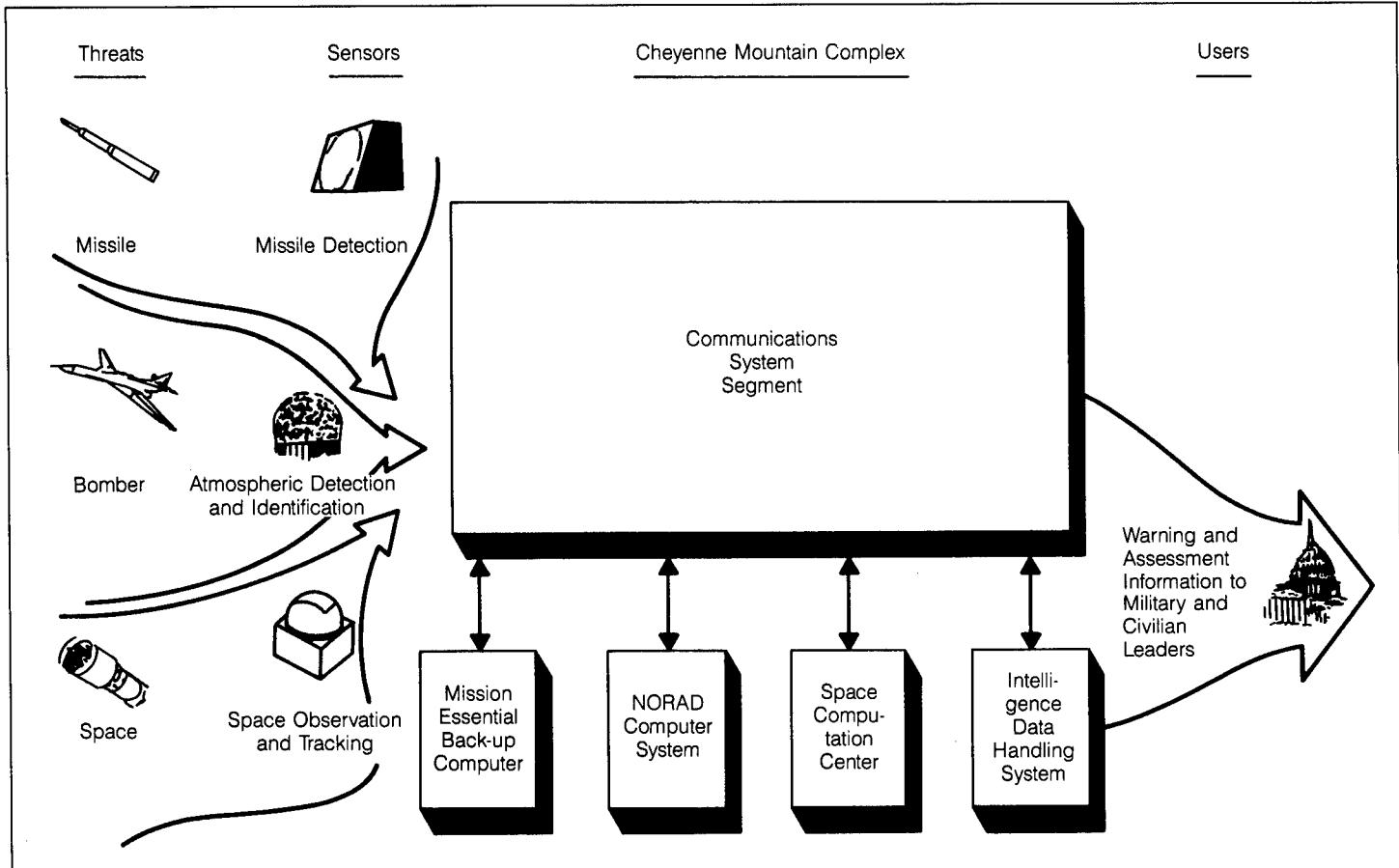
The U.S. Space Command, located in Colorado Springs, Colorado, is a unified command¹ made up of three components—Air Force Space Command, Naval Space Command, and United States Army Space Command—that oversees certain missile warning and space surveillance activities. The Commander of the U.S. Space Command also serves as the Commander-in-Chief of NORAD. The Air Force Space Command provides training, and equips and operates missile warning and space operations centers that enable NORAD and the U.S. Space Command to perform their missions.

The command and control center for NORAD and the U.S. Space Command is the Cheyenne Mountain Air Force Station, which houses data processing and communications equipment supporting the tactical warning and attack assessment mission. The equipment and subsystems in Cheyenne Mountain form the nucleus of the integrated Tactical Warning and Attack Assessment (TW/AA) system, which the Air Force calls a “system of systems.”

Although TW/AA is continually being modified in response to changing missions and threats, it currently consists of hardware and software predominantly dating from the mid-1970s. As the system has aged it has become increasingly more difficult to obtain parts for support. It also has limited ability to incorporate new requirements desired by the Air Force. Principal subsystems include the Communications System Segment, Space Defense Command and Control System, Intelligence Data Handling System, NORAD Computer System, and Mission Essential Backup System. Figure 1.1 shows the current system within the Cheyenne Mountain complex.

¹A command made up of components from two or more services to perform an operational mission under a single commander.

Figure 1.1: NORAD TW/AA System



Past Problems Have Shaped Today's TW/AA Management and Modernization

The Cheyenne Mountain complex became operational in 1966; by the early 1970s, a major hardware and software replacement program (the 427M) was underway. This program had major problems primarily because Defense required that NORAD use specific hardware and software that could not meet requirements. Specifically, the Joint Chiefs of Staff had required NORAD to use Honeywell computers and operating system software obtained from an existing Defense-wide contract that was unsuited to the "real-time" processing needs of the missile warning system. These limitations made it necessary for NORAD to undertake major software modifications and change operational procedures within the complex. Even then the system could not perform as fully as expected. The need for significant software modification complicated

the program, increased costs, and effectively precluded completion of the program, which has never achieved full operational capability.

In November 1979 and June 1980 the TW/AA system generated three false attack indications, which attracted adverse publicity and nearly caused an international crisis.

- On November 9, 1979, false indications of a mass raid were caused by inadvertent introduction of test scenario data into the on-line missile warning computers.
- On June 3, 1980, false attack indications were caused by a faulty component in a communications computer.
- On June 6, 1980, false attack indications were again caused by the same faulty communications component during fault isolation testing.

**TW/AA Review
Recommends "System of
Systems" Approach**

In response to the false attack indications generated in 1979 and 1980, the Air Force Chief of Staff commissioned a special management review of U.S. Air Force support to the TW/AA system. It sought to determine whether organizational or procedural changes were necessary to ensure accurate and timely warning and assessment information to support military forces and national decision making during crises. The review, begun in July 1980 under the direction of the Air Force Inspector General, found that the Air Force neither recognized nor managed TW/AA subsystems as a single system. According to the Inspector General, this led to (1) divided approaches on how subsystems were acquired, integrated, and managed, and (2) a lack of end-to-end direction for operations concepts, doctrine, and procedures.

The review recommended that Air Force headquarters issue a program management directive to recognize the TW/AA system as a system of systems, made up of specifically identified subsystems. This action would legitimize the warning and assessment system as a total system and would place day-to-day responsibility and accountability for improvements and management within a single management structure.

**TW/AA Management
System Is Unique**

Responding to the recommendations of the special management review, the Joint Chiefs of Staff established an executive management structure for the warning and assessment system with an executive agent and executive manager. The executive agent—the Air Force Chief of Staff—was charged with consolidating the management of technical integration

for the system.² The executive manager was to be responsible for the overall management and control of the TW/AA system and for reviewing and validating all proposed changes to it. In March 1981 the Air Force implemented this management structure with the Commander of NORAD's U.S. component³ as the executive manager. The Air Force also established the Air Force Systems Command as a separate acquisition manager.

In September 1985 restructuring of the U.S. component of NORAD created the United States Space Command. As a result of this restructuring, the position of executive manager was removed from the user, U.S. Space Command, and maintained by the Commander of the Air Force Space Command, one of the components that supports the user.

TW/AA Management Support Structure

The Air Force created a complex organizational structure to support TW/AA, involving many relationships and entities (commands, boards, working groups), which has evolved and grown over time. The responsibility and accountability for life cycle management⁴ of TW/AA and its modernization programs is divided among six commands, a testing center, and over 200 directorates, boards, and working groups.⁵

The organizational chart (see fig. 1.2) portrays the relationships among the principal organizations supporting the TW/AA modernization programs (the chart omits 213 subordinate organizations or groups). The chart depicts the two key using commands—NORAD and U.S. Space Command. Several commands support the using commands through resource management for the current warning and assessment system and the acquisition of new systems. These commands include the

- Air Force Space Command, responsible for organizing, training, equipping, and operating missile warning and space operations resources;

²Technical integration implies maintaining technical integrity (i.e., confidence that a given input will result in a known, desired output) not only of individual subsystems, but of the entire system.

³In 1981 the United States component to NORAD was the Aerospace Defense Command. NORAD and the Aerospace Defense Command were key users of the TW/AA system. Along with commanding the U.S. component, the Commander, Aerospace Defense Command, was also the Commander in Chief of NORAD and the TW/AA executive manager.

⁴Life cycle management is the process for administering an automated information system over its whole life—requirements definition, acquisition, operations and maintenance—with emphasis on strengthening early decisions that shape automated information system costs and utility.

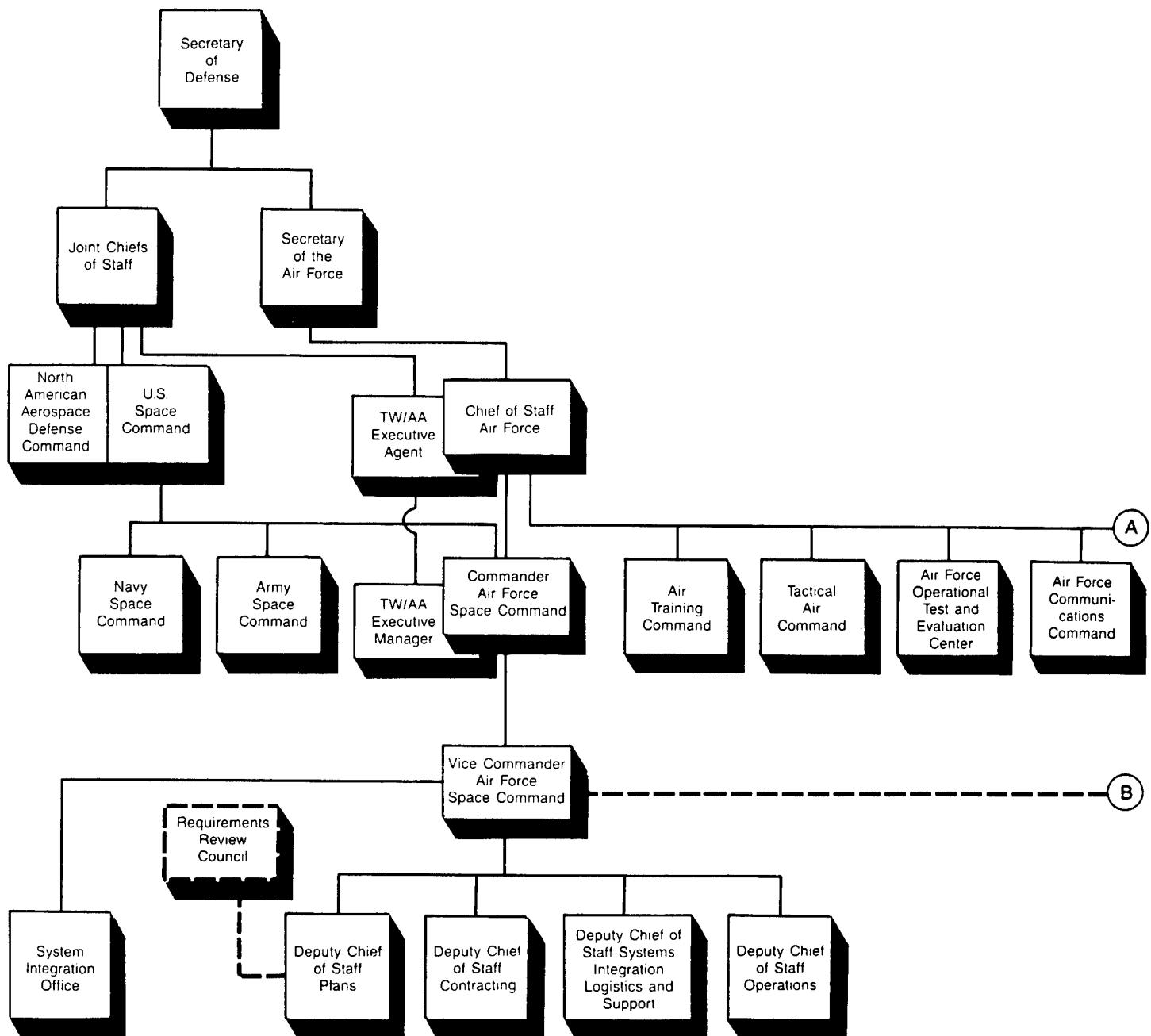
⁵See appendix I for a description of the responsibilities of these commands.

- Air Force Systems Command, responsible (through its Electronic Systems Division) for managing warning and assessment system acquisitions;
- Air Force Logistics Command, responsible for maintenance and logistics support;
- Air Force Communications Command, responsible for communications support; and the
- Air Training Command, responsible for training support.

Among these commands, the Air Force Space Command and Air Force Systems Command's Electronic Systems Division have predominant responsibility for the five Cheyenne Mountain modernization programs.

Chapter 1
Introduction

Figure 1.2: TW/AA Organizational Structure



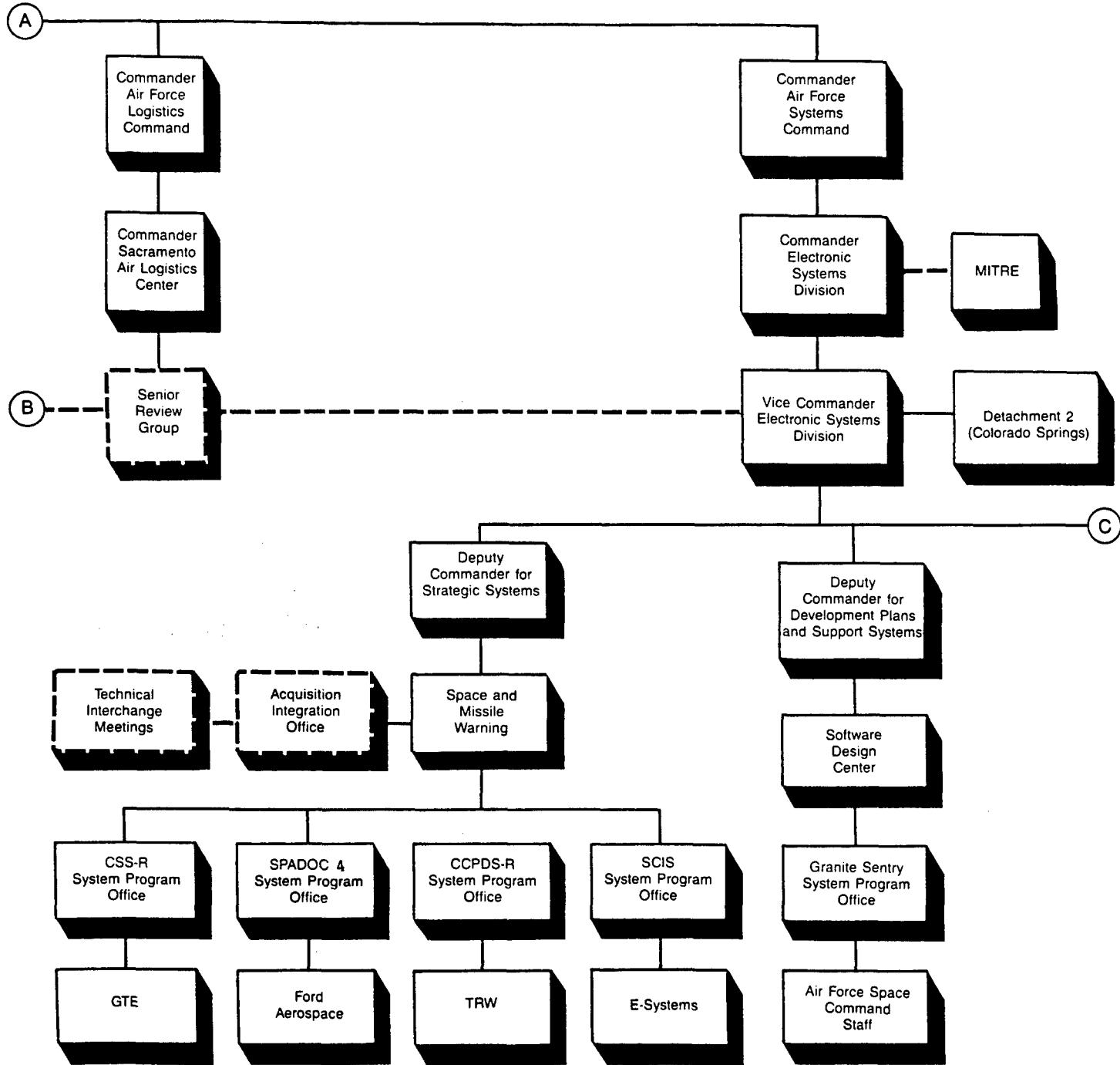
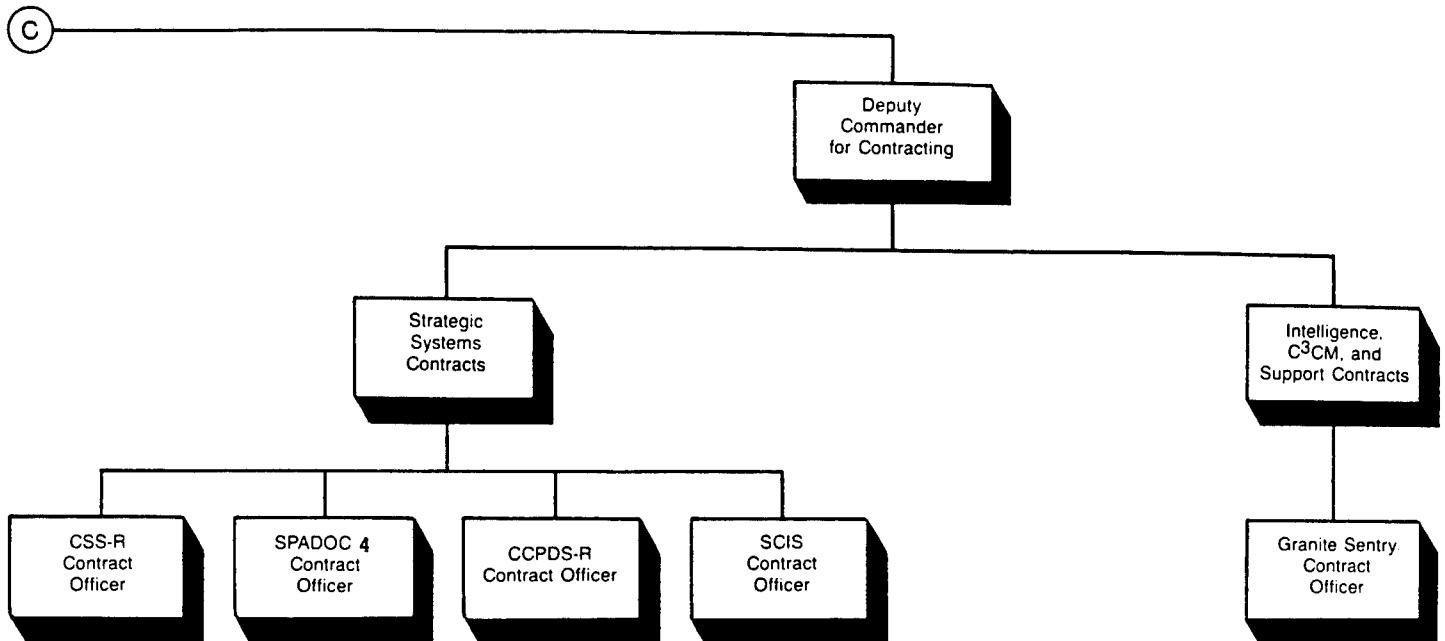


Figure 1.2: (continued)



Note: This figure does not include 150 subordinate organizations and contractors, and 63 boards, panels, and working groups.

- Primary line of authority during the life cycle management process of the five TW/AA modernization programs.
- Primary and other line of communication that provided support during the life cycle management process of the five TW/AA modernization programs.
- Line organization with primary or support responsibility during the life cycle management process of the five TW/AA modernization programs.
- Other organizations providing primary or other support during the life cycle management process of the five TW/AA modernization programs.

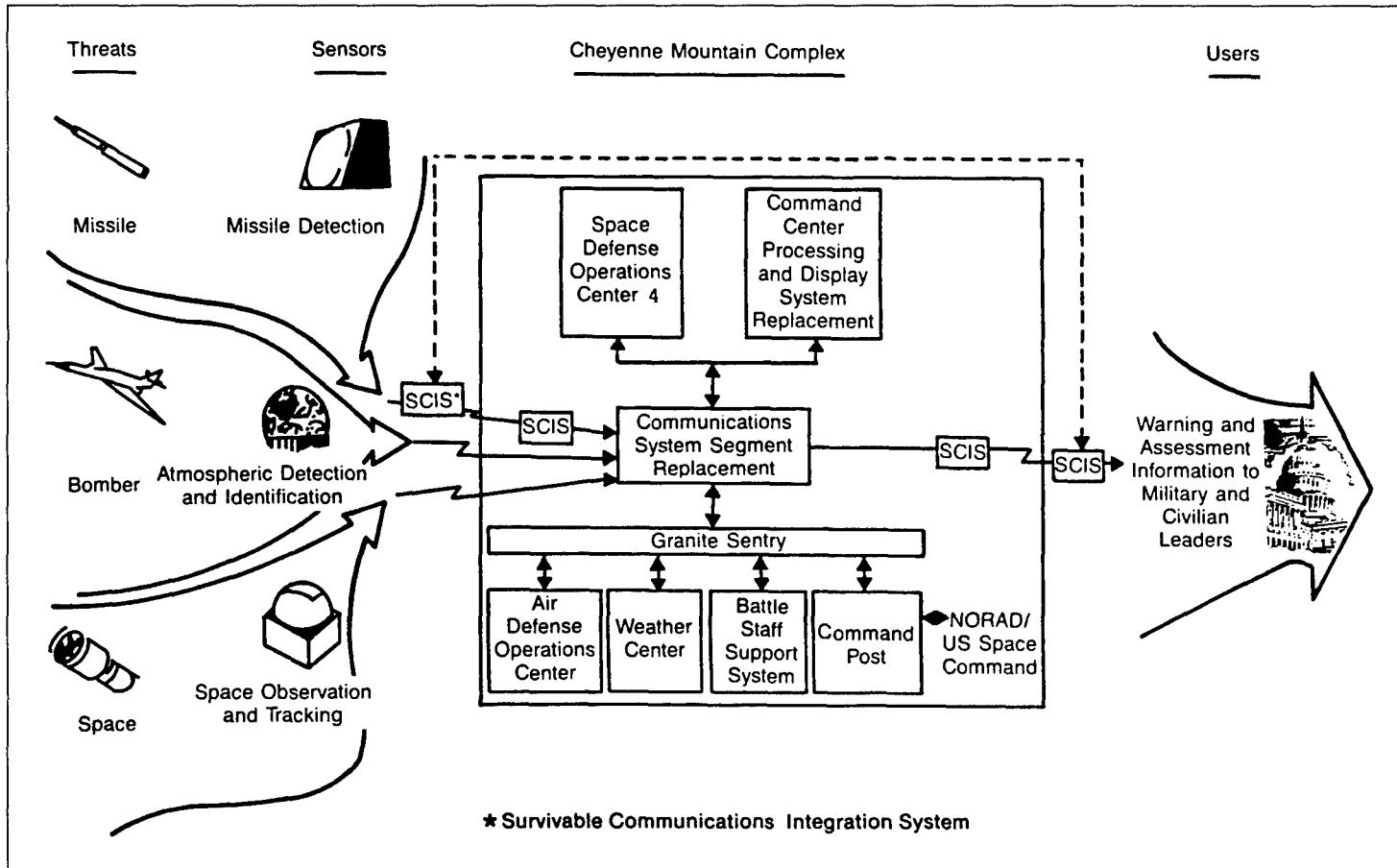
Air Force Recognized Need
to Modernize TW/AA

We and various congressional committees have pointed out problems with the TW/AA computer system in addition to the false attack warnings of 1979 and 1980. Our 1978 report recommended replacing NORAD subsystems with state-of-the-art computer hardware and software systems.⁶ A 1982 report by the House Committee on Government Operations specifically recommended that the Secretary of Defense take immediate steps to ensure that NORAD acquire the latest computer technology available to meet its mission requirements.⁷ In response to these and other concerns, the Air Force in the early 1980s, began five modernization programs to replace or upgrade computer systems at the Cheyenne Mountain complex. These ongoing programs are the (1) Communications System Segment Replacement (css-R), (2) Space Defense Operations Center 4 (SPADOC 4), (3) Command Center Processing and Display System Replacement (CCPDS-R), (4) Survivable Communications Integration System (SCIS), and (5) Granite Sentry (GS)—a program to modernize various command posts within Cheyenne Mountain. Figure 1.3 shows the relationships among the five TW/AA modernization programs, and appendix II more fully describes them.

⁶NORAD's Information Processing Improvement Program—Will It Enhance Mission Capability? (LCD-78-117, Sept. 21, 1978).

⁷NORAD Computer Systems Are Dangerously Obsolete (HR-97-449, Mar. 8, 1982).

Figure 1.3: Proposed NORAD TW/AA System



Cost Estimates for the Five TW/AA Modernization Programs

In 1981 the Air Force indicated that planning for replacement of the NORAD computer system was complete and initial operating capability for the replacement system would occur by March 1987, when the last of the separately acquired modernization programs would be complete.⁸ The initial estimated cost for the five modernization programs was \$968.2 million. By May 1988, the programs' total cost had risen to approximately \$1.3 billion. As of October 1988, their completion was expected in 1994. Table 1.1 summarizes estimated expenditures and proposed additional costs for each program.

⁸Initial operating capability indicates when the system has been certified by the System Integration Office to meet all technical integrity requirements.

Table 1.1:Estimated Expenditures and Future Costs for the Five TW/AA Modernization Programs

(Dollars in millions)				
	Fiscal 1988	Years 1989	To complete	Total
CSS-R	162.8	41.1	78.0	281.9
GS	41.0	35.6	139.4	216.0
SCIS	56.2	22.0	49.1	127.3
CCPDS-R	65.3	50.5	154.0	269.8
SPADOC 4	276.1	24.7	114.5	415.3
Total	601.4	173.9	535.0	1,310.3

Congress Directed Increased Defense Oversight

Only one of the original cost estimates for the five modernization programs met the threshold that would have required Department of Defense-level oversight throughout development.⁹ According to Air Force officials, as cost estimates for another program rose above Defense-established thresholds, Defense and the Air Force did not reconsider the original decision to manage the programs without formal Defense oversight.

In September 1988 the Congress directed that all of NORAD's modernization programs be consolidated and placed under the oversight of the Defense Acquisition Board.¹⁰ The Congress further required that the Board conduct a management review of the consolidated program during fiscal year 1989 and report the results to the Congress.

Objectives, Scope, and Methodology

At the request of the former Chairman, Subcommittee on Defense, House Committee on Appropriations, we reviewed how effectively the Air Force was integrating five programs for modernizing the integrated Tactical Warning and Attack Assessment system's data processing and communication capabilities.

To understand how the Air Force is organized to manage system integration, we tracked and documented the TW/AA organizational structure, emphasizing the organizations involved in the integration process and their interrelationships. In addition, we sought to determine how the Air Force is managing the resolution of system integration problems, and to determine the impact that these problems may have on the warning and

⁹Department of Defense Directive 5000.1, Major System Acquisitions, dated March 12, 1986.

¹⁰Making Appropriations for the Department of Defense; House of Representatives Report No. 1002, 100th Congress, 2nd Session (Conference Report).

assessment system. To do so, we selected four critical problems to review in detail from among 48 problems identified by the Air Force as involving all or most of the five TW/AA modernization programs. The Air Force believes that these problems, if left unresolved, would disrupt TW/AA system integration.

The four integration problems we reviewed were:

- Communications protocols: a set of rules that govern communications among computer systems. A single protocol standard is needed for effective communication among all Cheyenne Mountain computer subsystems. The five TW/AA modernization programs are being designed and developed using three communications protocols. These incompatible protocols will not provide effective communications among the Cheyenne Mountain subsystems.
- Common message set or format: the form or format for data transmitted from sensors (e.g., radars) to computer subsystems. Every ballistic missile sensor transmitting data to TW/AA has a unique message set, but the modernization programs are being designed to accept only certain of these formats. A common message set is necessary for efficient communications among Cheyenne Mountain subsystems and between the subsystems and related sensors.
- Inconsistent message loads: since the Cheyenne Mountain computer subsystems process messages, the sizes of the subsystems are based in part upon the number of messages that must be processed: the more messages to be processed, the larger the system. Several subsystems are being sized to different message-load requirements. For example, the Communications System Segment Replacement system, which must handle nearly all messages among the subsystems in Cheyenne Mountain, is being sized to process a smaller message work load than other subsystems.
- Network security policy: a network security policy is necessary to ensure that subsystems are designed to safeguard sensitive or classified information. No network security policy for Cheyenne Mountain currently exists.

To determine how the TW/AA organizational structure handled these integration problems, we traced the resolution process for these four critical problems through the TW/AA organizational structure.

We examined cost, schedule, management, and contract information for the five modernization programs provided by the Defense Department and the Air Force. We also reviewed a number of Air Force studies that

discussed the TW/AA management structure and made recommendations to improve it. We worked at the Office of the Secretary of Defense, the Office of the Joint Chiefs of Staff, and at Air Force headquarters in Washington, D.C.; NORAD, the U.S. Space Command, and the Air Force Space Command at Colorado Springs, Colorado; and the Air Force Systems Command's Electronic Systems Division at Hanscom Air Force Base, Massachusetts. We also interviewed key officials at all of these locations.

Our audit was conducted from June 1987 through November 1988. Information has been updated through February 1989. We interviewed responsible Defense and Air Force officials, program representatives, contractors, and consultants, and have incorporated their comments where appropriate. We performed our work in accordance with generally accepted government auditing standards.

Integration Problem Resolution Is Cumbersome, Lengthy, and Ineffective

The TW/AA subsystems must interact with each other to provide complete and reliable warning and assessment information to our national leaders. Each subsystem is being separately acquired and developed, and each employs different computer and communications technologies. The process of interconnecting these subsystems so that together they can effectively accomplish NORAD's mission is called system integration. Successful system integration should result in the design and delivery of a complete subsystem that will work in concert with other TW/AA subsystems to fulfill specific design, operational, and management objectives.

Ineffective planning and implementation could result in subsystems that cannot be integrated. If critical integration problems are not resolved, the subsystems will not operate effectively together. Further, if integration problems are not identified and resolved in a timely manner, individual programs may suffer significant engineering, scheduling, and/or funding impact.

The Air Force has long recognized the importance of managing the integration process. According to three Air Force studies,¹ dating as far back as 1977, program management functions were fragmented among numerous organizations. The studies recommended establishing a single focal point for integration management. However, this recommendation was never effectively implemented. Instead, the organizational structure became increasingly more complex and fragmented, incorporating numerous commands, directorates, offices, boards, and working groups. This multi-command, multi-organizational structure divides responsibility and accountability for the system integration process, making it difficult to identify and resolve integration problems.

Critical integration problems exist among the five TW/AA modernization programs we reviewed. These include subsystems that must communicate with each other being built to different communications standards, and widely differing attack scenarios being used to determine the work loads for related subsystems. Although the Air Force recognized some major integration problems as early as 1984, it did not officially track them until 1986. In assessing four of the most critical problems, we

¹Independent Review Group report, performed at request of Commander, Aerospace Defense Command (Apr. 11, 1977).

Special Management Review of U.S. Air Force Support to the Tactical Warning and Attack Assessment System (Sept. 2, 1980).

System Integration Joint Task Force Report (Nov. 4, 1983).

found that they had been addressed for years within the cumbersome resolution process and that, to date, none had been resolved.

Despite unresolved integration problems, development work continues on the five TW/AA modernization projects—a \$1.3 billion effort. Potential solutions became more costly, complex, and harder to implement. These unresolved problems could disrupt the Air Force's ability to effectively integrate the modernized subsystems into a fully operational TW/AA.

Cumbersome Structure Divides Responsibility; Places Accountability Above Those Needing to Act

Under the TW/AA executive management structure, the single focus of accountability is the executive agent, the Air Force Chief of Staff. Only he, at the top level of the Air Force, can be held accountable for the collective success or failure of the modernization programs, since no single commander below him has authority or responsibility to manage the TW/AA system through its life cycle. Since 1981, a large, complex, multi-organizational structure has evolved under the executive agent to separately manage, acquire, and maintain parts of the TW/AA system. This structure includes three key commands and at least 263 formal and informal organizations, boards, panels, and working groups, each with a separate role in integrating parts of the warning and assessment system (see chap. 1). Within this structure, system integration problems are being documented, formally tracked, and discussed in various forums within and between the commands—but not resolved.

In May 1986 a committee of general officers—the Senior Review Group—was established to help resolve integration problems across command lines. This group, composed of the vice-commanders of the Air Force Space Command and the Electronic Systems Division and the Commander of the Sacramento Air Logistics Center, is charged with ensuring that a structure is in place to address all integration issues. After integration problems are identified by organizations within any one of the participating commands, the Senior Review Group should be briefed on the problems, and either resolve them or set a course of action for resolution.

We found integration problems were not being brought to the Senior Review Group in a timely manner because of the excessive coordination needed between the numerous organizations with their varying roles and responsibilities. When problems were put before the group, they were not resolved, in part because the divided authority and responsibility among commands necessitated decision making by consensus.

Although decisions to resolve critical integration problems were not forthcoming from the group, the problems were also not raised to higher level decision makers for resolution, but instead were consistently referred back to staff within one or more of the commands for further coordination and analysis. Two integration problems—inconsistent message loads and the need for standard communications protocols—illustrate the inefficiency of this resolution process.

Extended Coordination and Analysis Has Kept Message-Load Requirements Inconsistent

Cheyenne Mountain's computer subsystems send, receive, and process messages within the mountain and to and from outside users. The size of each of the subsystems is determined, in part, by the number of messages that must be processed. As mentioned in chapter 1, the message load requirements for the computer subsystems are inconsistent: the Communications System Segment Replacement, which must handle nearly all messages among the subsystems, is being sized to process a smaller message work load than any of the subsystems. The Air Force's unsuccessful attempts at resolving this problem illustrate the cumbersome and ineffective nature of the organizational structure.

The Air Force became aware of this problem in 1985. The potential solution establishing a common message-load scenario and modifying the individual subsystems' contracts as needed—was agreed to by planners from both the Air Force Space Command and the Electronic Systems Division as early as June 1986. However, as of February 1989, the scenario had not been made final, contracts had not been changed, and the three modernization program contractors affected had continued to build their respective systems using specifications that were known to be inconsistent.

We found a cumbersome, multi-organizational group attempting to resolve the message-load problem through a series of meetings and staff analyses. Personnel from 17 directorates or working groups had met and analyzed the problem or referred it for someone else's action a total of 57 times since March 1986. Although the Senior Review Group was briefed on three occasions between August 1986 and September 1987, it has not taken any effective action to resolve the problem.

Project engineers for Mitre Corporation, performing systems engineering tasks on behalf of the Electronic Systems Division, identified the need for a consistent message-load requirement among the modernization projects in March 1986. Air Force Space Command analysts had, since 1985, been developing an integrated bomber, missile, and space attack

scenario from which such message loads could be determined. By August 1986 the integrated scenario had been outlined and the Senior Review Group briefed on the actions needed to resolve the problem. However, the search for consensus on specifics of the scenario, analyses of details on how it would affect ongoing contracts, or the actual decision to modify the modernization contracts have been the subject of an additional 51 meetings, reviews, and analyses (including two additional briefings to the Senior Review Group) over a 2-1/2-year period. Further analysis is continuing.

In August 1986, when the Senior Review Group first considered the problem of inconsistent message-load requirements, the three Cheyenne Mountain subsystems affected were still being designed. At this early stage, we believe that system changes could have been incorporated into the individual systems with minimal impact. Today these programs are under development using software and hardware with work load assumptions known to be inconsistent and potentially wrong. As a result, changes could be needed to completed portions of the subsystems in order to meet the TW/AA mission. The effect of these changes on cost and schedule is yet unknown, but a preliminary estimate by Mitre engineers evaluating the attack scenario suggests that, unless the Air Force makes major changes to the scenario assumptions, the Communications System Segment Replacement system alone could be faced with up to a \$150-million modification.

Benefits From Standard Protocols Lost Through Cumbersome Integration Structure

A communications protocol is a set of rules that governs communications among computer systems. By implementing standard protocols, different manufacturers' computer systems can communicate with each other. The warning and assessment subsystems—including the Communications System Segment Replacement, the principal communications system within Cheyenne Mountain—are using three different protocols. The Air Force recognizes that a single set of protocols is needed for all Cheyenne Mountain computer subsystems to effectively communicate but, after 3 years of coordination, analysis, and study, a standard set of protocols has not been implemented. Further, as time has passed, development on the TW/AA modernization programs has progressed to the point where the Air Force now believes that costs to implement a standard set of protocols across the programs is prohibitive. It believes it must now wait until the programs have been completed (sometime in the mid-1990s) and retrofit each subsystem to incorporate the standard protocols—an undertaking that could, in the long term, be more costly and time-consuming than either specifying standard protocols initially or

directing the change to a standard protocol in early design phases of the modernization contracts.

The time-consuming, cumbersome nature of the integration structure is evidenced in the process the Air Force used to attempt to resolve the protocol standards problem. The Air Force Space Command recognized the need for common communications interfaces for the modernization programs in January 1986. During the first 10 months of 1986, both the Space Command and the Electronic Systems Division evaluated candidate protocols and began assessing the effects of various alternatives on each program. In October 1986 the Senior Review Group was told that the open systems interconnection protocols, a set of non-government standards developed by the International Standards Organization, which Defense has subsequently specified as mandatory defense-wide for new development, should be adopted as the standard for all Cheyenne Mountain subsystems. The Air Force Space Command adopted the open systems interconnection protocols in November 1986, and its support organizations began developing the standards for their use. By July 1987 the standards were in final draft form, and the Air Force had already specified the use of the protocols in the second phase of the Granite Sentry program.

In a May 1987 study, Mitre informed the Air Force that converting to open systems interconnection, if done at that time, would cost from \$2.5 to \$4.3 million, would reduce schedule risks on the Communication Systems Segment Replacement contract, and could have similar positive effects on the other modernization programs. The stage would appear to have been set for modifying the modernization contracts and resolving the protocol problem quickly, but the Air Force did not implement the standards it adopted, and the contractors for the individual modernization initiatives continued development of the five subsystems using the original, incompatible specifications.

In January 1988, 6 months after the July 1987 draft standards, Air Force Space Command's boards and working groups reviewed and validated the protocol standards as a requirement for the Communications System Segment Replacement and interfacing systems, and communicated the requirement to the Electronic Systems Division. Five more months elapsed while the Division used its engineering support contractor to evaluate the requirement and obtain an engineering change proposal from the Communications System Segment Replacement contractor. (Other contractors were not asked to submit engineering change proposals for modification to their contracts.)

In May 1988, 1 year after Mitre had forecast a \$2.5 million to \$4.3 million cost for timely implementation of the open systems interconnection standard, the Communications System Segment Replacement contractor advised the Electronic Systems Division that the new requirement would cost \$13.2 million and entail a 6-month schedule delay. The Air Force continued to defer the decision to implement the standard. In August 1988 the decision of whether to implement the protocols was presented to the Senior Review Group. On the basis of the contractor's estimated cost and schedule impact information, and the unavailability of additional funding, the Senior Review Group recommended further postponement.

Responding to congressional direction² to develop a plan for resolving Cheyenne Mountain's communications problems, the Air Force prepared a study in October 1988³ that estimated the cost of incorporating the protocols in the Communications System Segment Replacement, Space Defense Operations Center 4, and Command Center Processing and Display System Replacement programs at \$26 million and the schedule delay at approximately 1 year. (The Granite Sentry Program already specifies open systems interconnection protocols.) Citing this cost and schedule impact, the Air Force will delay implementing the standard protocols until the programs are installed in Cheyenne Mountain, estimated now to be some time in 1994. The Air Force has thus avoided increased costs to current contracts, but it will lose the potential benefits of having designed the protocols into the system during development and could face potentially higher costs for retrofitting the standard into completed subsystems. In total, 22 organizations and 2 contractors were involved in at least 74 coordination activities, meetings, and actions to choose, develop, and approve the protocol standards—which have still not been implemented.

Other Integration Problems Faced Similar Resolution Hurdles

The two remaining integration problems we reviewed, involving common message sets and network security policy, experienced similar coordination problems, delays, and lack of decision making. In April 1985 the Air Force decided to establish a new format for messages generated by ballistic missile sensors. After almost 4 years of meetings, studies, and analyses, the contract changes to solve the most significant message

²Making Appropriations for the Department of Defense; House of Representatives Report No. 1002, 100th Congress, 2nd Session (Conference Report).

³Air Force Final Report, Communications System Segment Replacement Program for Cheyenne Mountain, Oct. 15, 1988.

set "disconnect"—the incompatibility between the Survivable Communications Integration System and the Communications System Segment Replacement—have not been made final and the cost and schedule impact of making them have not been established.

The Air Force Space Command and the Electronic Systems Division acknowledged the need for a network security policy in August 1986. A draft standard was developed by the Air Force Space Command after 2 years of work, but according to Command officials, no planned milestones exist for making the security policy final, and they expect that coordinating the finished policy could take approximately 2 more years before contract modifications can be requested through the Electronic Systems Division.

Accountability in Program Management Is Lacking

Systems development and integration for the separately acquired and managed TW/AA subsystems occur amid constant management change. Moreover, we found that although both directives and the body of current procurement thought call for consistent program management, the average tenure for the Electronic Systems Division's program managers among the modernization programs was less than 2 years. Turnover was also frequent among commanders, principal deputies, and command managers (representatives of the user). With the exception of the program managers for the Survivable Communications Integration System and Granite Sentry projects, every key player at every level of management on every project changed several times during the lives of the programs.

The projects we reviewed demonstrated a pattern of deferring rather than solving problems occurring during system development. For example, for more than 3 years the Air Force deferred resolving fundamental technical problems in the Space Defense Operation Center 4 program to subsequent program phases. The Air Force ultimately developed a subsystem that could not deliver its required operational capability. We believe that, in the aggregate, this environment of dispersed responsibilities, multiple reassignment of managers, and deferring rather than resolving problems has diluted accountability for development and integration and has jeopardized program success.

Management Structure, Turnover Stymie Program Management Continuity Goal

Defense and others have long pointed out the need for continuity in the management of major acquisitions and, specifically, acquisitions of automated information systems. Throughout this decade defense acquisition directives have called for clear lines of authority, responsibility, and accountability in program management. Furthermore, directives since March 12, 1986, have called for the tenure of key personnel, specifically program managers, to be sufficiently long to provide continuity and management stability in major acquisition programs. Moreover, Defense directives dealing with automated information systems, such as Cheyenne Mountain's computer systems, have, since October 17, 1978, called for these systems to be managed throughout each phase of their life cycles (i.e., from the first definition of mission need through acquisition, operations, and maintenance) by a single individual who cannot be reassigned without the approval of senior officials.

This call for management continuity and accountability is neither new nor restricted to Defense directives. With particular emphasis on NORAD's Cheyenne Mountain systems, an April 1977 Air Force review

team reported that due to the lack of a single manager, problems in the 427M program (NORAD's last major modernization effort) were not resolved. In September 1978 we reiterated the review team's findings and concluded that the lack of a single manager for Cheyenne Mountain systems was contributing to prolonged systems development, sizable cost overruns, and user dissatisfaction with untimely and unreliable system products.¹ Similar findings were reported in the September 1980 Air Force special management review of NORAD systems and in two subsequent Air Force studies.

According to a Report to the President on Defense Acquisition,² the Congress had specified by 1984 that the minimum tenure for program managers of major Defense acquisitions should be 4 years. Further, the report concluded that the acquisition process needed to be streamlined, and that the Defense Department needed to establish unambiguous authority for overall acquisition policy, clear accountability for life cycle management responsibilities, and direct lines of command for those with program management duties.

Notwithstanding this extensive, long-standing direction, the Air Force's command structure fragmented responsibility and authority among multiple commands and contributed to the evolution of a large, cumbersome management system. No single focal point of accountability exists below the Chief of Staff of the Air Force. Critical decisions on development of individual programs cannot logically be addressed by the Air Force's top officer, but they are not being resolved at lower levels. The impact of this fragmented management structure, we believe, has been further exacerbated by the Air Force's approach of separately funding, acquiring, and managing individual Cheyenne Mountain subsystem modernization projects, rather than by treating TW/AA system as a single system subject to program review and oversight by the Defense Acquisition Board.

Within this management environment, the average tenure for the program managers responsible for the five major TW/AA modernization programs has been 22.5 months. The turnover among other key managers, up to and including the commanders of the Air Force Space Command and the Electronic Systems Division, has been frequent. Table 3.1 details the turnover in program and command managers.

¹LCD-78-117, Sept. 21, 1978.

²A Report to the President on Defense Acquisition by the President's Blue Ribbon Commission on Defense Management, April 1986.

Table 3.1: Program Management Stability

Program	Timeframes	Electronic Systems Division program managers	Air Force Space Command command managers
CSS-R	1980-89	3	5
SPADOC 4	1984-89	5	8
CCPDS-R	1983-89	4	3
SCIS	1986-89	2	3
GS	1986-89	1	3

Deferring Critical Decisions Diffuses Accountability

In the TW/AA systems management environment, where authority and responsibility are diffused and management continuity has not been maintained, the practice of deferring problems to later years of the program rather than solving them when they arise, further dilutes accountability. When problems are deferred beyond changes in managers and organizations, specific accountability is lost. For example, portions of both the Space Defense Operations Center 4 and Communication System Segment Replacement programs have been accepted by the Air Force, although they have cost more than originally estimated and do not satisfy original specifications. Although development is continuing, we question whether these programs can successfully fulfill their specified mission functions. Specific accountability for problems deferred throughout systems development cannot be readily assigned.

Fundamental Technical Problems With Spadoc Remain After Years of Development

The Air Force's acquisition of Space Defense Operations Center 4 provides a case study of what happens when managers allow a program to continue without resolving system weaknesses and identified problems.

Space Defense Operations Center 4 block A, the first of three major development phases,³ began in April 1983, and development concerns started to surface shortly thereafter. As early as August 1983, the Mitre Corporation, the Electronic Systems Division's engineering contractor responsible for monitoring the technical aspects of Space Defense Operations Center 4 development, informed the Air Force that it was concerned about the adequacy of the Center's performance prediction model, security design progress, and overall software design quality. These concerns were repeatedly brought to the Air Force's attention throughout the block A development process, and were confirmed when

³The Space Defense Operations Center 4 acquisition is divided into three evolutionary blocks—A, B, and C.

block A failed to satisfy most mission-related performance requirements during testing by the Air Force Operational Test and Evaluation Center in June 1987 and the Air Force Space Command during January and February 1988. Although block A had not successfully completed any of the system performance tests attempted, the Air Force accepted the block A system in April 1988, and deferred meeting the performance requirements to block B, already in development.

Development of block B, which incorporates and, therefore, depends upon the block A hardware and software, began in June 1986. Although block A was not completed, the Air Force was aware of significant block A performance deficiencies that could seriously affect block B development. At the preliminary design review in February 1987, the contractor proposed adding computing capability that it believed necessary to achieve the performance requirements. The Air Force did not agree because it was unclear whether adding computing capability would be sufficient to achieve the required performance levels. Subsequently, according to Mitre, problems similar to those which affected block A development occurred in block B.

Since February 1987, the Air Force and the contractor have been in a stalemate about how to best meet system performance requirements. The Air Force maintains that all requirements as specified in the contract are needed, still valid, and must be achieved. The contractor has stated that upgraded computers are needed to meet the requirements. The contractor is continuing to design the block B system, even though it has not agreed with the Air Force on what hardware and/or software design changes are needed to achieve all system performance requirements.

The Air Force could have suspended development of the Space Defense Operations Center 4 program until problems were addressed and resolved, but it did not. Rather, it continued to act as if the problems would somehow be solved in the next phase, repeatedly deferring problem resolution into the future.

Five years and four program managers later, the block A system accepted by the Air Force in April 1988 did not meet requirements, and the Air Force again deferred achieving them until the development of block B. While block B has been in development for over 2 years, the contractor's system design is unacceptable to the Air Force because it too does not achieve required performance levels. As it did in block A,

the Air Force is again deferring resolution of block B design and development problems.

**Air Force Accepted
Communications Unit
With Known Deficiencies;
Problems May Remain
Until 1990s**

Development of a technical control unit⁴ for the Communications System Segment Replacement program has experienced significant schedule delays and performance problems. The planned installation date has been delayed from 1986 to 1990 and, after 5 years of development, it cannot fully meet contract specifications. However, the Air Force accepted the unit in November 1988 without having either corrected technical deficiencies or having conducted complete end-to-end testing (continuous from start to finish without a system failure) of the unit. The Air Force has deferred resolution in 12 areas of deficient performance, including such high risk deficiencies as the inability to restore the unit to operation quickly enough after a power loss to meet NORAD mission requirements. The Air Force intends to have the contractor correct the deficiencies during subsequent development of block II of the communications subsystem. The Air Force now believes that the technical control unit, already delivered and accepted, cannot be installed until sometime in 1990.

Even if technical deficiencies in the development effort were resolved, the technical control unit would still not work with other NORAD subsystems because the unit was designed to a wiring standard that is not compatible with equipment currently in the mountain. The Air Force has been aware since 1984 that Cheyenne Mountain wiring was incompatible with that of the technical control unit, but has not resolved the problem by changing the wiring either in the mountain or in the technical control unit. As of October 1988, the Air Force had not resolved the wiring standard problem and had not requested the funds needed to implement a solution. However, the Air Force has initially estimated that it will take about 18 months and up to \$5 million to resolve the wiring problem within Cheyenne Mountain.

⁴Technical control is the function within the communications system that ensures that usable communications lines are always available by maintaining back-up lines and communications equipment that can rapidly replace any live line or piece of equipment that malfunctions.

Conclusions and Recommendations

The Air Force plans to spend more than \$775 million through fiscal year 1989 to modernize and replace the computer and telecommunications subsystems at NORAD's Cheyenne Mountain complex. After almost 8 years of development, no phase of the five modernization programs is operational. The Air Force estimates that it will need at least an additional \$535 million and five more years to complete the modernization initially scheduled for completion in 1987.

The most recent Air Force estimates are subject to question because longstanding, serious integration problems—problems that can disrupt the individual modernization initiatives from working together—remain unresolved. The process for resolving development and integration problems is cumbersome, lengthy, and ineffective, and resolution has been continually deferred to future program phases. Moreover, accountability has been diffused across a fragmented management structure and further diluted by frequent turnover in key command and management positions.

The Air Force began its Cheyenne Mountain modernization effort with two significant management structure limitations:

- The Air Force structure for acquiring complex automated data processing systems places development responsibility in a command separate from the user.
- Authority for TW/AA system integration (the executive agent) is placed at a level too high to be effective in resolving problems.

The Air Force magnified the problems inherent in its management structure when it approved separate funding, acquisition, and management of the five subsystems, rather than following the recommendations of earlier Air Force management reviews—including the special management review endorsed by the Joint Chiefs of Staff—to treat the TW/AA system as a single entity, with a single manager.

In the absence of a single, accountable manager with authority for the total TW/AA system, the Air Force began managing subsystem development and integration by consensus through a proliferation of boards and working groups across the involved commands. Instead of streamlining the procurement and integration processes, the effect has been to expand the structure and divide responsibility. The net effect of a cumbersome structure, divided responsibility, poor management continuity, and deferred problem resolution has been to deliver subsystems that do

not meet specifications and will not effectively integrate without additional, costly changes. The Air Force has clearly spent time, effort, and money with less than satisfactory results. In our view, however, corrections can be made to the management and development of this critical system. We believe that the Department of Defense has the opportunity, with at least \$535 million yet to be committed and much development work remaining, to go beyond the initiatives already directed by the Congress¹ and recommended in various Defense management reviews to improve the management of the TW/AA system.

Recommendations to the Secretary of Defense

To encourage effective management over at least \$535 million planned to be spent on the TW/AA system, we recommend that the Secretary of Defense restructure the roles and responsibilities of the key managers within the TW/AA executive management structure. The Secretary should designate a single manager, at a level below the Air Force Chief of Staff, with responsibility, authority, and accountability for the entire life cycle of the TW/AA system, from requirements through acquisition to operations and maintenance. The Secretary should further ensure that the designated system manager has control over the necessary budgetary and management resources to carry out his responsibilities.

We also recommend that the Secretary direct the designated system manager to revalidate system requirements with the user for each modernization program. The Secretary should further direct the system manager to include in the congressionally-mandated Defense Acquisition Board management review (1) the actions and timetable for resolving known system integration problems, (2) the mechanism the manager intends to employ to improve continuity in program management, and (3) the actions to identify and resolve future integration problems in a timely fashion.

Agency Comments and Our Evaluation

In its May 11, 1989, comments on a draft of this report (see app. III), the Department of Defense concurred or partially concurred with all the report's findings and recommendations. Defense updated the TW/AA Program Management Directive on January 12, 1989, to recognize the many

¹In September 1988 the Congress directed that NORAD's five modernization programs be consolidated and placed under the oversight of the Defense Acquisition Board. See Making Appropriations to the Department of Defense; House of Representatives, Report No. 1002, 100th Congress, 2nd Session (Conference Report).

commands involved in the systems' life cycle and to assign responsibilities to these organizations. Defense states that under the Program Management Directive, the system executive manager—Commander, Air Force Space Command—is the single manager below the Air Force Chief of Staff with responsibility, authority, and accountability for the Technical Warning and Attack Assessment System, from requirements through acquisition oversight to operations and maintenance. We believe that Defense has taken a positive step to improve the management of the troubled TW/AA modernization effort by clearly designating a single manager and by its intention to streamline, consolidate, and eliminate, as necessary, the large complex support structure encompassing over 200 directorates, boards, panels, and working groups. However, we believe that constant management attention will be needed to ensure that the management problems inherent in the modernization programs are resolved.

Inconsistent Message Loads Not Resolved

Defense disagreed with our assessment that the message load requirements for the Cheyenne Mountain computer subsystems are inconsistent. However, Defense has not provided evidence to show that the CSS-R is being built to process all the messages that must pass through it. Defense documentation shows that the CSS-R, which must handle nearly all messages among the subsystems, is being sized to process a smaller work load than any of the other subsystems. Defense believes that by making technical tradeoffs and changes in operational procedures, all programs will be sized correctly, and no significant changes will be required. However, no detailed analysis has been completed to support this position or show what the cost and schedule impact would be on the other programs because of technical tradeoffs. Further, the Mitre Corporation, Electronic Systems Division's engineering support contractor, raised many questions on operational procedures and concepts for the integrated TW/AA system that we believe need to be resolved before the CSS-R's correct message load can be established. At the time of our review, an updated integrated TW/AA operational concept has not yet been completed.

SPADOC 4 Technical Problems Remain

In response to whether SPADOC 4 block A and B's technical problems were resolved in a prudent manner, Defense stated that while block A does not meet all operational requirements, it does provide a significant improvement over current capabilities and achieved initial operating capability in April 1989. Further, Defense expects the remaining issues in block A development to be resolved during block B critical design

review that was scheduled for May 1989. Finally, they stated that recent management actions taken by the Air Force have resulted in improved performance by the contractor.

During the first 5 years of development, the Air Force did not achieve the objectives of minimizing cost, achieving milestones, and reducing risk, creating a situation where achieving the program's technical objectives is still doubtful. Further, the Air Force's practice of problem deferral was a primary cause of many of the system's continuing difficulties. Even though the Air Force and Ford have recently begun to work together to improve contractor performance, many critical technical problems with SPADOC 4 remain. Even if the block A problems are addressed in the block B critical design review, the challenge remains for the Air Force and the contractor to implement actions to resolve the complex issues facing the SPADOC 4 program and, thus, minimize future cost growth and schedule delays.

An Incomplete CSS-R Was Accepted by the Government

Defense stated that the Air Force has not accepted the block I semi-automated technical control unit for the CSS-R program. However, a contract acceptance form (DD Form 250) signed by Electronic Systems Division in November 1988 shows that the block I computer hardware was accepted from the system development contractor without accepting the application software. Further, final payment of \$1.8 million, which was held as residual payments until acceptance of block I, was paid to the contractor. These actions by the Air Force clearly show that block I hardware was accepted by the government.

Further, under Electronic Systems Division's agreement, not only did the government accept an incomplete system, it also accepted responsibility for maintaining the system while the contractor finished software development. Acceptance of the computer hardware in advance of complete system delivery transferred ownership and maintenance responsibility from the contractor to the government. Electronic Systems Division has agreed to pay the system development contractor \$3 million to maintain the block I computer hardware from November 1988 through initial operational capability of the block I unit in Cheyenne Mountain, planned for April 1991.

Air Force Command Life Cycle Responsibilities for the TW/AA System and Its Five Cheyenne Mountain Modernization Programs

The TW/AA system is supported by an organizational structure consisting of 6 commands, a testing center, 196 subordinate organizations and contractors, and 63 boards, panels, and working groups. This structure has been put in place by the Air Force and has evolved and grown over time to provide life cycle management for the TW/AA system and the five modernization programs. Life cycle management consists of (1) requirements setting and validation, (2) acquisition, (3) operations, and (4) maintenance.

The organizations carrying out these functions include the:

- Air Force Space Command,
- Air Force Systems Command,
- Air Training Command,
- Tactical Air Command,
- Air Force Operational Test and Evaluation Center,
- Air Force Communications Command, and the
- Air Force Logistics Command.

Air Force Space Command

The Air Force Space Command organizes, trains, equips, and operates missile warning and space operations resources. The Command is responsible for setting and validating requirements for new and upgraded systems and for day-to-day operations and maintenance of the warning and attack system hardware and software. The Air Force Space Command consists of four Deputy Chief of Staff organizations, the System Integration Office, and the Requirements Review Council related to TW/AA integration.

Deputy Chief of Staff for Plans

The Deputy Chief of Staff for Plans is responsible for the definition of requirements for the TW/AA modernization programs and for representing Air Force Space Command during development of these programs. Within this organization are the five modernization program command managers who act as the Command's focal point for contact and coordination with the Electronic Systems Division.

Deputy Chief of Staff for Contracts

The Deputy Chief of Staff for Contracts advises the commander on contracting issues and manages worldwide contracting programs.

Appendix I
Air Force Command Life Cycle
Responsibilities for the TW/AA System and
Its Five Cheyenne Mountain
Modernization Programs

Deputy Chief of Staff for Operations	The Deputy Chief of Staff for Operations manages all aspects of current operations and solutions to short term TW/AA system problems. This includes testing new and upgraded software and hardware and training system operators.
Deputy Chief of Staff for Systems Integration, Logistics, and Support	<p>The Deputy Chief of Staff for Systems Integration, Logistics, and Support is responsible for maintaining the hardware and software for the existing TW/AA system. The organization is also responsible for the integration and support of all command surveillance; warning; and command, control, communications and computer systems. This includes</p> <ul style="list-style-type: none">• security• system planning,• acquisition and implementation,• system integration,• contracting,• logistics,• day-to-day management of the operations, and maintenance of existing mission command and control systems. <p>After development, testing, and System Integration Office certification, this organization will be responsible for the day-to-day maintenance of the five modernization programs.</p>
System Integration Office	The System Integration Office is responsible for ensuring end-to-end technical integrity ¹ of the TW/AA system by acting on matters affecting the credibility and/or timeliness of automated missile warning information being received, processed, or transmitted within the system. The System Integration Office also reviews proposed changes to the system for compatibility with architecture and engineering requirements. The Office also coordinates and publishes additional information concerning System Integration Office managerial and technical requirements for certification to be used by the TW/AA acquisition agencies.

¹The technical integrity of a system is the characteristic of producing proper output response for a given input stimulus.

Appendix I
Air Force Command Life Cycle
Responsibilities for the TW/AA System and
Its Five Cheyenne Mountain
Modernization Programs

**Requirements Review
Council**

The Requirements Review Council is a general officer-level group chartered to review and validate requirements for all new acquisition programs, including the five Cheyenne Mountain modernization programs. The Council also reviews and validates all changes to requirements for existing programs prior to submission to the Electronic Systems Division. The Council is responsible for controlling requirements' growth and determining which requirements' changes should become part of an upgrade program contract.

**Air Force Systems
Command**

The Air Force Systems Command is responsible for acquisition of assigned electronic systems and programs including automated data processing systems, operational support projects, and engineering service programs. Systems Command provides program guidance, funding, priorities, and reprogramming requirements to Air Force Headquarters and to the field.

The Command designs, constructs, tests, and purchases weapons and equipment and initial spare parts for Air Force operational and support commands. Primary emphasis is given to aeronautical, space, electronic, missile, and armament systems. The Command also provides oversight responsibility for the modernization initiatives throughout the acquisition cycle, and assistance to Electronic Systems Division program managers.

**Electronic Systems
Division**

The Electronic Systems Division plans, manages, and conducts technological development, acquisition, logistic support planning, installation, and delivery of command, control, communications, and intelligence systems, and ground electronic systems for the Air Force Systems Command. Specifically, Division is responsible for planning and managing the development, acquisition, installation, and delivery of TW/AA subsystems, including the five modernization programs.

Detachment 2

Detachment 2 is an extension of Headquarters, Electronic Systems Division, for all its activities in the Colorado Springs area. Detachment 2 serves as the resident Air Force Systems Command focal point for all Command activities related to the Cheyenne Mountain complex. The Detachment interacts with NORAD and Air Force Space Command's Deputy Chief of Staff for Plans on support for development of operational requirements and long range planning in command, control, communications, and intelligence, and provides broad acquisition assistance.

Appendix I
Air Force Command Life Cycle
Responsibilities for the TW/AA System and
Its Five Cheyenne Mountain
Modernization Programs

Deputy Commander for Strategic Systems

The Deputy Commander for Strategic Systems manages the development and acquisition of major electronic systems for use by the National Command Authorities and Air Force commanders of strategic forces.

Space and Missile Warning Directorate and System Program Offices

The Directorate and system program offices manage the development and acquisition of the Electronic Systems Division's space and missile warning systems. The Directorate exercises overall control of assigned programs, ensures necessary coordination within and outside the directorate, and performs functions necessary for program offices to manage the acquisition process for the four modernization programs.

Acquisition Integration Office

The Acquisition Integration Office ensures end-to-end technical integrity of the TW/AA system acquisition programs. The office analyzes and evaluates areas common to several subsystems, such as test, logistics, and documentation of the TW/AA network, to identify potential cost and manpower savings through more efficient operation.

The Acquisition Integration Office mission is to minimize the risk of introducing new programs into the TW/AA system by

- ensuring the interoperability of new programs with the existing TW/AA system, and
- managing integration of new subsystems into the operational environment.

Technical Interchange Meeting

Technical Interchange Meeting is an organization that provides a forum for the exchange of information on TW/AA integration activities and the coordination of related activities. This organization will address areas of concern to more than one TW/AA subsystem, including those that affect operational systems, such as:

- status of system integration problems,
- review of new potential system integration problems,
- status of individual integration tasks, and
- other topics relating to TW/AA integration.

Technical Interchange Meeting includes representatives of:

- Electronic Systems Division/Acquisition Integration Office;
- Air Force Space Command's System Integration Office;

Appendix I
Air Force Command Life Cycle
Responsibilities for the TW/AA System and
Its Five Cheyenne Mountain
Modernization Programs

- Air Force Space Command's Deputy Chief of Staff for Plans;
- Air Force Space Command's Deputy Chief of Staff for Systems Integration, Logistics, and Support;
- Electronic Systems Division's Detachment 2, and
- others as required.

Deputy Commander for Development Plans and Support Systems

The Deputy Commander for Development Plans and Support Systems plans, manages, and implements advanced electronic command, control, and communication systems.

Software Design Center

Electronic Systems Division's Software Design Center furnishes management services and direct support to program offices to improve the acquisition, performance, and maintenance of Air Force mission-critical computer resources.

Deputy Commander for Contracting

The Deputy Commander for Contracting is responsible for contracting activities at the Electronic Systems Division. This office represents the commander on all matters pertaining to contract policy with Air Force Systems Command headquarters, U.S. Air Force headquarters, and other government agencies and private industry. The Deputy Commander establishes policy and guidance and provides contractual support for system acquisition; research and development; and services, material, and supply contracts.

Directorate for Strategic Systems Contracts

The Directorate for Strategic Systems Contracts directs and manages contracting activities. This includes acquisition planning and contractual actions necessary to negotiate and award contracts, assisting in assembling and approving contract packages, preparing justification review documents, assisting in preparing work statements, reviewing contractor sources, soliciting proposals, and negotiating prices, terms, and conditions.

Appendix I
Air Force Command Life Cycle
Responsibilities for the TW/AA System and
Its Five Cheyenne Mountain
Modernization Programs

**Directorate for
Intelligence, Command,
Control, and
Communications
Countermeasures and
Support Contracts**

The Directorate provides contracting support for intelligence systems.

**Air Training
Command**

The Air Training Command recruits, trains, and educates Air Force personnel. The Command is responsible for the initial fundamental training of operators.

Tactical Air Command

The Tactical Air Command develops requirements for air defense, organizes, trains, equips, and maintains combat-ready forces capable of rapid deployment and ensures that air defenses are ready to meet the challenges of wartime air defense.

**Air Force Operational
Test and Evaluation
Center**

The Air Force Operational Test and Evaluation Center is a separate operating agency under Air Force headquarters. The Commander of this center reports directly to the Air Force Chief of Staff. The Center is the Air Force's independent test agency, responsible for testing, under operationally realistic conditions, new systems being developed for the Air Force and for multi-service use. The Center's efforts focus on assessing the operational effectiveness and suitability of the Air Force's future weapons systems and supporting equipment. The Center seeks to reduce risk in the acquisition process by determining how well systems perform when operated and maintained by Air Force personnel in a realistic operational environment. Results from the Center's tests are used at all levels of the Air Force, the Department of Defense, and the Congress in making program decisions leading to the production and fielding of systems.

Air Force Communications Command

The Air Force Communications Command provides operational commanders and the National Command Authorities² with the information systems and air traffic services needed in peace or war. The Command performs day-to-day operational support and carries out long-range information systems planning. As the central manager for communications-electronics, data automation, and air traffic services, the Communications Command engineers, acquires, installs, operates, maintains, and manages Air Force information systems. The Command provides telephone systems, base communications centers, computer facilities, ground radio and satellite stations, and an air traffic control system.

Air Force Logistics Command

The Air Force Logistics Command is the designated system program manager for the Cheyenne Mountain Complex. As such, the Command is assigned management responsibility for the logistic support and the technical integrity of the system. The Command is a key component of system readiness and sustainability to meet wartime situations.

²The National Command Authorities are officials at the highest level of government, including the President of the United States and the Secretary of Defense.

The Five TW/AA Modernization Programs

In the early 1980s, the Air Force began five modernization programs so that our nation's leaders would have timely, unambiguous warning and assessment information in the event of a missile or bomber attack on the United States. These five major programs will replace or upgrade computer systems at the NORAD Cheyenne Mountain complex. These programs are

Communications System Segment Replacement Program: The program is intended to ensure uninterrupted communications to and from Cheyenne Mountain subsystems. Messages received from the various missile, air, and space sensor systems are to be distributed by this replacement system to mission centers at Cheyenne Mountain for processing.

The replacement system is being developed in two separate blocks. Block I is intended to automate the monitoring and technical control of the communications lines entering Cheyenne Mountain. Block II is planned to be a message distribution subsystem that receives messages, checks them for completeness, and forwards them to various NORAD computer systems for processing.

Space Defense Operations Center 4 Program: The program is intended to be a data processing and communications center that can monitor space activities, provide timely warning of any threat or attack, and protect satellites by identifying and suggesting satellite maneuvers to avoid threats. The program is being implemented in three blocks. Block A is intended to provide computer equipment and software to automate existing manual space defense operations and to automate cataloging for the space object data base. Block B is intended to enhance current automated space surveillance functions for 400 high-interest satellites. Block C is to complete the automated capability needed to consolidate the U.S. Space Command's space defense data processing functions into one command and control center.

Command Center Processing and Display System Replacement Program: The program is intended to replace the current missile warning data processing system. It is intended to provide computer systems with additional capability to support the ballistic missile warning and attack assessment mission.

Survivable Communications Integration System Program: The program is intended to enhance communications robustness by providing NORAD

with the capability to transmit critical missile warning messages simultaneously over multiple communications systems. It is intended to provide the ability to use up to five communications systems and a secure voice capability between individual sensor sites and command centers.

Granite Sentry Program: This program is intended to improve the U.S. Space Command's ability to perform a variety of attack warning and assessment missions. The program will replace the Modular Display System and the air defense portion of the NORAD Computer System. The program will be implemented in five phases. These phases will upgrade (1) the Air Defense Operations Center, (2) interim enhancement to the Command Post, (3) the NORAD Command Post, (4) interfacing with other Cheyenne Mountain subsystems, and (5) the Battle Staff Support Center and Weather Support Unit.

Comments From the Department of Defense



ASSISTANT SECRETARY OF DEFENSE

WASHINGTON, D.C. 20301-3040

COMMAND, CONTROL,
COMMUNICATIONS
AND
INTELLIGENCE

Mr. Ralph V. Carbone
Assistant Comptroller General
Information Management and
Technology Division
U.S. General Accounting Office
Washington, DC 20548

11 May 1989

Dear Mr. Carbone:

This is the Department of Defense response to the General Accounting Office (GAO) Draft Report, "ATTACK WARNING: Better Management Required To Resolve NORAD Integration Difficulties," dated March 8, 1989 (GAO Code 510225, OSD Case 7925). The Department partially concurs with all of the draft report findings and recommendations. Actions to correct the identified problems have already been initiated.

The Department fully recognizes the difficult and complex nature of the modernization underway at Cheyenne Mountain and agrees that there are significant management challenges to be faced during the acquisition process. The Air Force Chief of Staff is the Executive Agent for the technical integrity of the Integrated Tactical Warning/Attack Assessment System. He has designated the Commander, Air Force Space Command, as the System Executive Manager with the responsibilities for the end-to-end system. The Air Force has taken many constructive actions to improve the management of this difficult modernization effort. Enclosure 1 is a summary of the specific actions taken by the Air Force to better manage the integrated Tactical Warning/Attack Assessment modernization program at Cheyenne Mountain. The Department also fully recognizes the critical nature of the Cheyenne Mountain modernization and how vital this program is to the National defense. The Defense Acquisition Board will conduct a formal review of the integrated Cheyenne Mountain modernization program during FY 1989 and will report its findings to the Congress following the review.

The Department appreciates the opportunity to comment on the report in draft form. The detailed Department of Defense comments on the draft report findings and recommendations are provided in Enclosure 2. The additional comments offer further clarification of the Department of Defense positions. Suggested technical corrections were separately provided to members of the GAO staff.

Sincerely,

A handwritten signature in black ink, appearing to read "Gordon A. Smith".

Enclosures

SUMMARY OF ACTIONS TAKEN BY THE AIR FORCE
TO BETTER MANAGE THE INTEGRATED TW/AA SYSTEM

- The Air Force Chief of Staff is the Department of Defense Executive Agent for the technical integrity of the Integrated Tactical Warning/Attack Assessment System. He has designated the Commander, Air Force Space Command, as the System Executive Manager with responsibilities for the end-to-end system.
- The Air Force has elevated acquisition management oversight of these programs to the Assistant Secretary for Acquisition. Specifically, this will enhance management oversight and will require submission of a monthly program assessment report.
- The System Executive Manager conducted a detailed program review in March 1989 and will be conducting quarterly reviews of these programs starting in July 1989.
- Acquisition programs have been consolidated into a single Program Element.
- Consolidated programs are undergoing a Defense Acquisition Board review to be completed in FY89.
- The U.S. Space Command requested that the Air Force conduct a review of the Communications System Segment Replacement and the Space Defense Operations Center because of problems with these programs; in response, Air Force Systems Command initiated an Independent Review Team review of the programs that was completed in 1988.
- A new Program Management Directive was published on January 12, 1989, that updated and clearly assigned responsibilities in support of the Executive Management Structure.
- An Acquisition Integration Office was established in 1987 by the Headquarters, Electronics System Division to ensure the Tactical Warning and Attack Assessment System acquisition programs are technically integrated prior to final user acceptance.
- Headquarters, Electronic Systems Division is modifying their existing contracts to add a more flexible vehicle for assessment of requirements' changes prior to the formal Engineering Change Proposal stage. This has been one of the more significant stumbling blocks in the prior Communications System Segment Replacement and Space Defense Operations Center integration issues.
- Electronic Systems Division is forming a Site Activation Task Force in Colorado Springs responsible for installing, integrating and testing Electronic Systems Division-developed programs.
- Air Force Logistics Command, Air Force Systems Command and Air Force Space Command have implemented a plan to collocate all of the logistics support functions in centralized facilities in Colorado Springs.

Enclosure 1

GAO DRAFT REPORT - DATED MARCH 8, 1989
(GAO CODE 510225) OSD CASE 7925

"ATTACK WARNING: BETTER MANAGEMENT REQUIRED TO RESOLVE NORAD
INTEGRATION DEFICIENCIES"

DEPARTMENT OF DEFENSE COMMENTS

* * * * *

FINDINGS

- FINDING A: Past Problems Have Shaped Today's Tactical Warning and Attack Assessment System. The GAO reported that the Cheyenne Mountain complex became operational in 1966 and, by the early 1970s, a major hardware and software replacement program was underway. The GAO noted that the program has encountered major problems, primarily because the DoD required that North American Air Defense System use Honeywell computers and operating system software obtained from an existing Defense-wide contract that was unsuited to the "real-time" processing needs of the missile warning system. The GAO found that these limitations made it necessary for the North American Air Defense System to undertake major software modifications and change operational procedures within the complex; and even then the system could not perform as fully as expected. The GAO concluded that the need for significant software modification complicated the program, increased costs, and effectively precluded program completion, which has never achieved full operational capability. The GAO found that, in November 1979 and June 1980, the Tactical Warning and Attack Assessment System generated the following three false attack indications, which nearly caused an international crisis:
 - on November 9, 1979, false indications of a mass raid were caused by inadvertent introduction of test scenario data into the on-line missile warning computer;
 - on June 3, 1980, false attack indications were caused by a faulty component in a communications computer; and
 - on June 6, 1980, false attack indications were again caused by the faulty communications component during operational testing. (pp. 11-12/GAO Draft Report)

DoD RESPONSE: Concur.

- FINDING B: Tactical Warning and Attack Assessment Review Recommends "System of Systems" Approach. The GAO reported that, in response to the false attack indications generated in 1979 and 1980, a review begun in July 1980 (under the direction of the Air Force Inspector General) found that the Air Force neither recognized nor managed the integrated Tactical Warning and Attack Assessment System subsystems as a single system. The GAO noted that this led to (1) divided approaches on how subsystems were acquired,

Now on p. 2 and p. 11.

Enclosure 2

Appendix III
Comments From the Department of Defense

integrated, and managed and (2) a lack of end-to-end direction for operations concepts, doctrine, and procedures. The GAO reported that the review recommended Air Force headquarters issue a program management directive to recognize the Tactical Warning and Attack Assessment System as a system made up of specifically identified subsystems, in order to legitimize the warning and assessment system as a total system, and place day-to-day responsibility and accountability for improvements and management within a single management structure. The GAO observed that, in March 1981, in response to the report, the Joint Chiefs of Staff established and implemented an executive management structure for the warning and assessment system with (1) an executive agent, the Air Force Chief of Staff, charged with consolidating the management of technical integration for the system and (2) an executive manager, the Commander of the North American Air Defense System U.S. Component, responsible for overall management and control of the Tactical Warning and Attack Assessment System and for reviewing and validating all proposed changes to it. The GAO noted that the Air Force also established the Air Force Systems Command as a separate acquisition manager. The GAO reported that a subsequent restructuring of the U.S. North American Air Defense System component in September 1985, created the United States Space Command and the position of executive manager was transferred from the user, the U.S. Space Command, to the Commander of the Air Force Space Command, one of the components that supports the user. The GAO found that the Air Force created a complex organizational structure to support Tactical Warning and Attack Assessment, involving many relationships and entities (commands, boards, working groups). The GAO further found that the responsibility and accountability for life cycle management of Tactical Warning and Attack Assessment and its modernization programs is divided among six commands, a testing center, and over 200 directorates, boards, and working groups. The GAO noted that the Air Force Space Command and Air Force Systems Command Electronic Systems Division have predominant responsibility for the five Cheyenne Mountain modernization programs. (pp. 12-19/GAO Draft Report)

Now on p. 2 and pp. 11-17.

DoD RESPONSE: Concur. It is because of the original recommendations for a "system of systems" approach and the recognition of integration problems that the DoD created an executive management structure in 1981 to provide a single manager with oversight of the end-to-end system. That single manager is the System Executive Manager, who is also the Commander, Air Force Space Command. To further enhance the management of the system and in recognition of the many commands involved in the system life cycle, the 1981 Program Management Directive was updated on January 12, 1989, to assign more clearly the responsibilities to all tasked organizations.

The report indicates that management inefficiencies have occurred during this difficult acquisition process, which may be related to the complex nature of supporting infrastructure of boards, committees and working groups. In response, the Office of the Secretary of Defense will direct the Air Force to accomplish an independent management review of the infrastructure, with the specific intent of streamlining, consolidating and eliminating, as necessary, in order to improve the management decision process required to manage the Tactical Warning and Attack Assessment System throughout its life cycle. The Office of the Secretary of Defense will request that the Air Force report back within six months as to the independent review findings, conclusions and recommendations, and actions taken and if no action was taken, the

justification for the continued existence of the particular entity.

It should be recognized that the GAO, Air Force Inspector General and congressional investigations in the early 1980's were limited to the Ballistic Missile Tactical Warning and Attack Assessment System, not to the other mission areas of air defense or space. The DoD expanded the management of the system to include all three mission areas (ballistic missile, air and space) in 1984, with the creation of the Integrated Tactical Warning and Attack Assessment System.

- FINDING C: Air Force Recognized Need To Modernize Tactical Warning and Attack Assessment. The GAO reported that various GAO reports and congressional committees have pointed out problems with the Tactical Warning and Attack Assessment computer system and recommended replacing the North American Air Defense subsystems with state-of-the-art computer hardware and software systems. The GAO found that, in the early 1980s, in response to the cited problems, the Air Force began five modernization programs to replace or upgrade computer systems at the Cheyenne Mountain complex, including the following:
 - the Communications System Segment Replacement;
 - the Space Defense Operations Center;
 - the Command Center Processing and Display System Replacement;
 - the Survivable Communications Integration System; and
 - the Granite Sentry, a program to modernize various command posts within Cheyenne Mountain.

The GAO reported that, in 1981, the Air Force indicated planning for replacement of the North American Air Defense computer system was complete and initial operating capability of the replacement system would occur by March 1987, at an estimated cost for the five modernization programs of \$968.2 million. The GAO found, however, that by May 1988, the total program cost had risen to approximately \$1.3 billion and, as of October 1988, completion was not expected until 1994. The GAO noted that, initially, only one of the original cost estimates for the five modernization programs met the threshold that would have required Department of Defense-level oversight throughout development. The GAO found, however, that as cost estimates for the programs rose above Defense-established thresholds, neither the Office of the Secretary of Defense nor the Air Force reconsidered the original decision to manage the programs without formal DoD-level oversight. The GAO, however, reported that, in September 1988, the Congress directed (1) that all of the North American Air Defense system modernization programs be consolidated and placed under the oversight of the Defense Acquisition Board and (2) that the Board conduct a management review of the consolidated program during FY 1989 and report the results to the Congress. (pp. 19-23/GAO Draft Report)

DoD RESPONSE: Concur. A Defense Acquisition Board is planned for the summer of 1989, to provide DoD oversight of these programs. The programs

Now on p. 3 and pp. 17-19.

have also been consolidated into a single line item for congressional review. As part of the Defense Acquisition Board process, an independent cost estimate of the total Cheyenne Mountain Upgrade programs will be provided. The system has been added to the Office of the Secretary of Defense Operational Test and Evaluation oversight list to further ensure systems' tests are adequately planned and executed resulting in an operationally sound system.

These programs have also been designated as an Air Force Executive Program, with streamlined management, baselining and reporting requirements consistent with the program designation. Streamlined management includes the Program Director, Program Executive Officer, and the Air Force Acquisition Executive. The Acquisition Program Baseline serves as a contract between and among the Air Force Acquisition Executive, the Program Executive Officer and the Program Director to develop the system to satisfy the users' needs. Current reporting requirements include a monthly program assessment report. The report provides an assessment, of the health of the program in 10 key categories and identifies (1) problem areas, (2) actions being taken to resolve them, and (3) any request for assistance.

In addition, initiatives are also being implemented to refine the configuration control system established in 1987. This process ensures formal management of the system baseline. Recent internal management actions have led to a rewrite of the Configuration Control Directive, which will result in further streamlining, an extremely complex but critical process. The revised directive will also result in better coupling to the acquisition community. In addition, the Air Force Space Command concluded that several levels of review and boards were redundant and is in the process of eliminating them. The Air Force Space Command anticipates, as the mission evolves, further refinements to the structure will be required to support proper management of the life-cycle aspects of the systems acquisition, operation and maintenance, and baseline changes. These initiatives for improving the Executive Management Structure and Configuration Control System were validated and implemented by the System Executive Manager.

Each of these actions is designed to improve the overall management of the programs and insure that necessary controls are in place to deliver a fully integrated and effective integrated Tactical Warning and Attack Assessment System.

- **FINDING D: Integration Problem Resolution Is Cumbersome, Lengthy, And Ineffective.** The GAO reported that each of the separately acquired Tactical Warning and Attack Assessment subsystems must interact with each other to provide complete and reliable warning and assessment information. The GAO found, however, that each subsystem employs different computer and communication technologies. The GAO further found that ineffective planning and implementation could result in critical integration problems, which if not resolved, will prevent the subsystems from operating effectively together. The GAO also found that, if integration problems are not identified and resolved in a timely manner, individual programs may suffer significant engineering, scheduling, and/or funding impact. The GAO concluded that, despite the Air Force recognition of the importance of having a single focal point to manage the integration process, it has not done so. The GAO further

Appendix III
Comments From the Department of Defense

concluded that, instead, the Air Force organizational structure has become increasingly more complex and fragmented, incorporating numerous commands, directorates, offices, boards, and working groups. In summary, the GAO concluded that this multi-command, multi-organizational structure divides responsibility and accountability for the system integration process, making it difficult to identify and resolve integration problems. The GAO also found that the critical integration problems exist among the five Tactical Warning and Attack Assessment modernization programs, including (1) subsystems that must communicate with each other being built to different communications standards and (2) widely differing attack scenarios being used to determine the work loads for related subsystems. In addition, the GAO found that, although recognizing some major integration problems as early as 1984, the Air Force did not officially track them until 1986. The GAO observed that four of the most critical problems (which the Air Force had been addressing for years) had not been resolved. The GAO observed that, despite the unresolved integration problems, development work continued on the five modernization projects, at a cost of \$1.3 billion, and potential solutions became more costly, complex, and harder to implement. The GAO concluded that these unresolved problems could disrupt the Air Force ability to effectively integrate the modernized systems into a fully operational Tactical Warning and Attack Assessment System. (pp. 27-29/GAO Draft Report)

DoD RESPONSE: Concur. The DoD recognized the problems associated with the technical challenges inherent in software intensive acquisitions of this magnitude. The multi-national, multi-command, multi-function mission of the Tactical Warning and Attack Assessment System contributed to the complexity of the organization to manage these programs.

The Air Force has taken steps to resolve the integration problems. The Acquisition Integration Office was formed in April 1987, at the Electronic Systems Division to deal specifically with integration issues among the acquisition programs and to ensure that the interfaces work. Since that time the technical staff has identified 69 technical problems and has been able to resolve 38 of them to date. The remainder of the problems are being given daily management attention and the Air Force expects prompt resolution of these problems.

The Acquisition Integration Office has also developed several management tools to avoid some of the pitfalls encountered with the current upgrade programs in the future (i.e. Granite Vista II threat and system modeling effort). These tools include a Program Planning Management System which uses a very structured, computer aided process designed to provide programmatic technical, cost and schedule information for program director decision-making. By its very nature, this management system forces active involvement of all individuals in the system acquisition process. All work and all interfaces are completely defined by this process. Once an interface issue or technical problem is identified, resolution options are defined, costed (if necessary), and provided to Air Force Space Command for decision. In addition, the Air Force is also in the process of implementing a common Granite Vista II scenario for these programs.

- **FINDING E: Cumbersome Structure Divides Responsibility And Places Accountability Above Those Needing To Act.** The GAO reported that, under the Tactical Warning and Attack Assessment executive management structure,

Appendix III
Comments From the Department of Defense

Now on p. 5 and pp. 23-24.

the single focus of accountability is the executive agent, the Chief of Staff of the Air Force. The GAO noted that only he can be held accountable for the collective success or failure of the modernization programs, since no single commander below him has authority or responsibility to manage the system through its life cycle. The GAO found that a large, complex, multi-organizational, multi-command structure implementing the Tactical Warning and Attack Assessment System has been documenting, formally tracking, and discussing system integration problems, but with no resolution. The GAO reported that, in May 1986, a committee of general officers, known as the Senior Review Group, was established to ensure that a structure is in place to address and resolve or set a course of action to resolve all integration problems across command lines as organizations identify problems. The GAO found, however, that integration problems were not being brought to the Senior Review Group in a timely manner because of the excessive coordination needed between the numerous organizations with their varying roles and responsibilities. The GAO further found that, when problems were put before the group, they were not resolved--in part because the divided authority and responsibility among commands necessitated decision making by consensus. The GAO also observed that, when the Senior Review Group did not make resolution decisions, the problems were not raised to higher level decision makers for resolution, but instead were consistently referred back to staff within one or more of the commands for further coordination and analysis. (pp. 29-31/GAO Draft Report)

DoD RESPONSE: Partially concur. There now is a clearly defined single manager below the Air Force Chief of Staff who is designated as the System Executive Manager for the Integrated Tactical Warning and Attack Assessment System and he is the Commander, Air Force Space Command. While the position of System Executive Manager was established in 1981, the relationships among managers at that time may have been clouded. Recent Air Force guidance, Program Management Directive 1044(4), dated January 12, 1989, states "This individual is delegated responsibility for the overall management and control of the end-to-end Integrated Tactical Warning and Attack Assessment System technical integrity and for review and integration of all proposed technical and engineering changes to the Tactical Warning and Attack Assessment System." The Program Management Directive not only more clearly defines organizational roles, but also consolidates the System Executive Manager's authority in one document. In addition, it is because of the criticality of the mission of the Tactical Warning and Attack Assessment System that the Air Force has instituted a very deliberate process to control the evolution of this system.

In 1986, a Senior Review Group was established to, among other things, carefully review proposed acquisition changes to ensure the system is not adversely impacted. The Senior Review Group was established to expedite the process of solving these kinds of acquisition problems in what is inherently a complex development effort. The Senior Review Group was formed to focus and resolve acquisition issues, not all integration problems in the entire system. Since May 1986, eight Senior Review Group meetings have been held. Over 50 key action items and problems have been identified and resolved. Because of concerns raised regarding the effectiveness of the Senior Review Group, the Office of the Secretary of Defense will request an Air Force acquisition review and report on the effectiveness and responsiveness of the Senior Review Group, including: (1) a listing describing all items referred to

the group since its inception; (2) how long it took for the items to reach the Senior Review Group after they were initially identified as problems; (3) a summary of the group's decision on each item, including the underlying rationale; and (4) how each decision or lack of decision affected the integrity Integrated Tactical Warning and Attack Assessment System, cost, schedule, and integration.

- **FINDING F: Extended Coordination And Analysis Has Kept Message-Load Requirements Inconsistent.** The GAO reported that the message load requirements for the Cheyenne Mountain computer subsystems are inconsistent because the Communications System Segment Replacement, which must handle nearly all messages among the subsystems, is being sized to process a smaller message work load than any of the subsystems. The GAO found that the unsuccessful Air Force attempts at resolving this problem illustrate the cumbersome and ineffective nature of the organizational structure. The GAO noted that the potential solution to this problem (which was initially identified in 1985) was to establish a common message-load scenario and modify the individual subsystems contracts as needed. The GAO reported that, despite the June 1980 agreement by planners from both the Air Force Space Command and the Electronic Systems Division, as of February 1989: (1) the scenario had not been made final; (2) contracts had not been changed; and (3) the three modernization program contractors affected had continued to build their respective systems using specifications that were known to be inconsistent. The GAO found a cumbersome, multi-organizational group attempting to resolve the message-load problem through a series of meetings and staff analyses. The GAO observed that, since March 1986, personnel from 17 directorates or working groups had met and analyzed the problem or referred it for action a total of 57 times. The GAO reported that, while the Senior Review Group was briefed on three separate occasions between August 1986 and September 1987, it has not taken any effective action to resolve the problem. The GAO reported that, by August 1986, the need for a consistent message load requirement was well known among the Electronic Systems Command, the Mitre Corporation (the contractor), the Air Force Space Command and the Senior Review Group. The GAO found, however, that over a two and a half year period, the search for consensus on specifics of the scenario, analyses of details on how it would affect ongoing contracts, or the actual decision to modify the modernization contracts have been the subject of an additional 51 meetings, reviews, and analyses (including two additional briefings to the Senior Review Group)--and analysis continues. The GAO observed that, in August 1986, system changes could have been incorporated into the individual systems with minimal impact, when the Senior Review Group first considered the problem of inconsistent message-load requirements and the three Cheyenne Mountain subsystems affected were still being designed. The GAO observed, however, that today these programs are under development using software and hardware with work load assumptions known to be inconsistent and potentially wrong, which may result in changes to completed portions of the subsystems in order to meet the Tactical Warning and Attack Assessment mission. The GAO concluded that, while the effect of these changes on cost and schedule is not yet known, a preliminary estimate by Mitre engineers suggests that, unless the Air Force makes major changes to the scenario assumptions, the Communications System Segment Replacement system alone could be faced with up to a \$150 million modification. (pp. 31-33/GAO Draft Report)

Now on pp. 24-25.

DoD RESPONSE: Partially concur. The initial efforts to establish a common scenario focused on the information needed to support a response to a potential attack on North America. Subsequently, the Air Force developed a scenario or threat model in conjunction with North American Air Defense System and the U.S. Space Command that was validated in 1987 by the Defense Intelligence Agency. Although a first look at the scenario by Mitre Corporation indicated changes to Communications System Segment Replacement alone might cost as much as \$150 million, further analysis has improved Air Force understanding of the potential problem. By making technical trade-offs and changes in operational procedures, it is the Air Force technical staff view (although the detailed analysis is not complete) that all programs are sized correctly and no significant changes are required. Air Force analysis has initially concluded that the \$150 million cost referenced in the report, will be avoided. As previously mentioned, (see DoD responses to Findings B and E) the Air Force will be directed to review the efficiency of all working groups to reduce and streamline where possible.

- **FINDING G: Benefits From Standard Protocols Lost Through Cumbersome Integration Structure.** The GAO reported that the warning and assessment subsystems, including the Communications System Segment Replacement, the principal communications system within Cheyenne Mountain are using three different protocols, despite the Air Force recognition that a single set of protocols is needed for all Cheyenne Mountain computer subsystems to communicate effectively. The GAO found that, after three years of coordination, analysis, and study, a standard set of protocols still has not been implemented, and development on the Tactical Warning and Attack Assessment system modernization programs has progressed to the point where the Air Force now considers the cost to implement a standard set of protocols across the programs to be prohibitive. The GAO further found that the Air Force now maintains it must wait until the programs have been completed (sometime in the mid-1990s) and then retrofit each subsystem to incorporate the standard protocols—an undertaking that could be more costly and time-consuming than either specifying standard protocols initially or directing the change to a standard protocol in early design phases of the modernization contract would have been. The GAO reported that the time-consuming, cumbersome nature of the integration structure is evidenced by the following chronology of events in an attempt to resolve the protocol standards problem:
 - January 1986--the Air Force Space Command recognized the need for common communications interfaces;
 - October 1986--after 10 months of study, the Air Force Space Command briefed the Senior Review Group, recommending that the open system interconnection protocols be adopted as the standard for all Cheyenne Mountain subsystems;
 - November 1986--the Air Force Space Command adopted the open systems interconnection protocols, and its support organizations began developing standards for their use;

- July 1987--the standards were in final draft form and the Air Force had already specified the use of the protocols in the second phase of the Granite Sentry program; and
- May 1987--a Mitre study informed the Air Force that converting to open systems interconnection, if done at that time: (1) would cost from \$2.5 to \$4.3 million; (2) would reduce schedule risks on the Communications System Segment Replacement contract; and (3) could have similar positive effects on the other modernization programs.

The GAO concluded that the stage appeared to have been set for modifying the modernization contracts and resolving the protocol problems quickly, but the Air Force did not act to implement the standards it adopted and, therefore, the contractors for the individual modernization initiatives continued development of the five subsystems using the original, incompatible specifications. The GAO observed that, in January 1988, six months after the July 1987 draft standards, the Air Force Space Command boards and working groups reviewed and validated the protocol standards and communicated the requirement to the Electronic System Division, but five more months elapsed while that Division evaluated the requirement and obtained an engineering change proposal from the Communications System Segment Replacement contractor. The GAO noted that other contractors were not asked to submit engineering change proposals for modification to their contracts. The GAO reported that in May 1988, one year after Mitre had forecast a \$2.5 million to \$4.3 million cost for timely implementation of the open systems interconnection standard, the contractor advised the Electronic Systems Division that the new requirement would result in a cost of \$13.2 million and a schedule delay of six months for that program; the Air Force, however, continued to defer the decision to implement the standard. The GAO reported that, finally, in August 1988, the decision to implement the protocols was presented to the Senior Review Group, which recommended further postponement because of the contractor estimated cost and schedule impact information and the unavailability of additional funding. The GAO noted that a congressionally requested October 1988 Air Force study estimated the cost of incorporating the protocols in the Communications System Segment Replacement, the Space Defense Operations Center, and the Command Center Processing and Display System Replacement programs at \$26 million with a schedule delay of approximately one year. The GAO observed that, due to cost and schedule impact, the Air Force delayed implementing the standard protocols until the programs are installed in Cheyenne Mountain, estimated now to be sometime in 1994. The GAO concluded that, while the Air Force has avoided increased costs to current contracts, it will lose the potential benefits of having designed the protocols into the system during development and could face potentially higher costs for retrofitting the standard into completed subsystems. The GAO further concluded that, in total, 22 organizations and two contractors were involved in at least 74 coordination activities, meetings, and actions to choose, develop, and approve protocol standards, which have still not been implemented.

(pp. 33-37/GAO Draft Report)

DoD RESPONSE: Partially concur. The Transmission Control Protocol/Internet Protocol (TCP/IP) was established as the DoD standard protocol in 1978 and a military standard protocol in 1982; therefore the selection of TCP/IP as the Cheyenne Mountain Complex protocol standard was appropriate, and was

selected before Open Systems Interconnection (OSI) was a mature industry-wide accepted protocol. As a result of the evolution of the industry protocol standard, a follow-on management review determined that OSI should be used on all future programs. However, the Air Force believes that industry implementation of the OSI protocol is not yet sufficiently mature to warrant making the change now. The Air Force is developing a detailed technical plan to transition to the OSI protocols in the future. This plan will be a cost effective approach to implementing the protocols when standard industry implementations become sufficiently mature and commercially available to field in an operational command and control system. The acquisition programs that are in the process of being fielded have standard DoD protocols specified and will interoperate with each other.

- **FINDING H: Other Integration; Integration Problems Faced Similar Resolution Hurdles.** The GAO reported that the two remaining integration problems it reviewed, involving common message sets and network security policy, also experienced coordination problems, delays, and lack of decision making. The GAO noted that, in April 1985, the Air Force decided to establish a new format for messages generated by ballistic missile sensors. The GAO found that, after almost four years of meetings, studies, and analyses, the contract changes to solve the most significant message set "disconnect"--the incompatibility between the survivable Communications Integration System and the Communications System Segment Replacement--have not been made final and the cost and schedule impact of making them has not been established. The GAO also reported that the Air Force Space Command and the Electronic Systems Division acknowledged the need for a network security policy in August 1986, and a draft standard was developed by the Air Force Space Command after two years of work. The GAO found, however, that according to command officials, no planned milestones exist for making the security policy final and they expect that coordinating the finished policy could take approximately two more years before contract modifications can be requested through the Electronic Systems Division. (pp. 38-39/GAO Draft Report)

Now on p. 27.

DoD RESPONSE: Concur. The Air Force expects to complete the engineering change proposal to the Communications System Segment Replacement contract in July 1989, to implement the common message set. Air Force Space Command expects the network security policy to be finalized by December 1989. The policy will not impact program design and will be implemented in operational procedures. The requirements for each program have been tailored from DoD 5200.28STD, Trusted Computer Systems Evaluation Criteria, to meet each program's individual threat.

- **FINDING I: Management Structure, Turnover Stymie Program Management Continuity Goal.** The GAO reported that the systems development and integration for the separately acquired and managed Tactical Warning and Attack Assessment subsystems occur amid constant management change. The GAO found that, although both directives and the body of current procurement thought call for consistent program management, the average tenure for the Electronics Systems Division program managers among the modernization programs was less than two years, and turnover was frequent among commanders, principal deputies, and command managers (representatives of the user). The GAO noted that, with the exception of the program managers for the Survivable Communications Integration System and

Appendix III
Comments From the Department of Defense

Granite Sentry projects, every key player at every level of management on every project changed several times during the lives of the programs. The GAO reported that, in April 1977, an Air Force review team reported that, due to lack of a single manager, problems in the last major North American Air Defense System modernization effort were not resolved. The GAO noted that a September 1978 GAO report 1/ reiterated the Air Force findings and concluded that the lack of a single manager for Cheyenne Mountain systems was contributing to prolonged systems development, sizable cost overruns, and user dissatisfaction with untimely and unreliable system products. The GAO noted that similar findings were reported in the September 1980 Air Force special management review of North American Air Defense Systems and in two subsequent Air Force studies. The GAO reported that, by 1984, the Congress had specified the minimum tenure for program managers of major Defense acquisitions should be four years, so that continuity could be maintained in program management to help ensure successful systems. The GAO observed that an April 1986 report, "A Report to the President on Defense Acquisition," prepared by the President's Blue Ribbon Commission on Defense Management (known as the "Packard Commission"), concluded that the acquisition process needed to be streamlined and the Defense Department needed to establish unambiguous authority for overall acquisition policy, clear accountability for life cycle management responsibilities, and direct lines of command for those with program management duties. The GAO concluded, however, that despite this extensive, long-standing direction, the Air Force command structure fragmented responsibility and authority among multiple commands and contributed to the evolution of a large, cumbersome management system, with no single focal point of accountability below the Air Force Chief of Staff. The GAO further concluded that (1) critical decisions on development of individual programs cannot logically be addressed by the top Air Force officer and (2) they are not being resolved at lower levels. Finally, the GAO concluded that the impact of this fragmented management structure has been further exacerbated by the Air Force approach of separately funding, acquiring, and managing individual Cheyenne Mountain subsystem modernization projects, rather than treating the Tactical Warning and Attack Assessment System as a single system subject to program review and oversight by the Defense Acquisition Board. The GAO noted that within this management environment, the average tenure for the program managers responsible for the major Tactical Warning and Attack Assessment modernization programs has been 22.5 months, and the turnover among other key managers, including the commanders of the Air Force Space Command and the Electronic System Division, has also been frequent. (pp. 40-43/GAO Draft Report)

DoD RESPONSE: Partially concur. The GAO concluded from its review that the Air Force should establish a unique life cycle management structure for the Tactical Warning and Attack Assessment System, outside the normal DoD division of functional responsibilities between and among the operating major commands and supporting commands. While such a recommendation may seem attractive at first look, the reality of maintaining the necessary expertise and infrastructure to support each of the areas of specialization has

1/ GAO LCD-78-117, "NORAD'S Information Processing Improvement Program--Will It Enhance Mission Capability," dated September 21, 1978

Appendix III
Comments From the Department of Defense

(OSD Case 5005)

repeatedly convinced DoD and the Air Force of the wisdom of the present approach. There is a single manager, the System Executive Manager, and his authority, as defined by Joint Chiefs of Staff Memorandum 27-86 and Program Management Directive 1044(4), provides the single oversight umbrella intended in the GAO recommendations without restructuring Air Force major command roles and missions.

Air Force Space Command, in conjunction with the Commander in Chief and the Chairman, Joint Chiefs of Staff, is responsible for requirements development and definition with support from Air Force Systems Command (cost, technical and risk analysis). The Air Force Systems Command is responsible for development and acquisition to support operational requirements. The Air Force Space Command is responsible for operations. Air Force Logistics Command is responsible for support. These three commands work interactively to insure that the systems are affordable, supportable and satisfy user requirements. Each command has demonstrated its unique ability and developed the expertise to satisfy their specific mission with optimum utilization of resources. It is the Air Force Space Command's responsibility and authority to insure that the new and modified systems meet its requirements.

The turnover of personnel in the Air Force and in these particular programs is not unique in the DoD environment. With respect to the high level of turnover of program managers, Air Force Systems Command has taken several actions to improve the situation. First, as of May 1988, each Program Director with responsibility for an executive program is handpicked by the Commander, Air Force Systems Command, based upon proven performance and personal capabilities. Second, per DoD Directive 5000.23, dated December 9, 1986, tour length for Program Directors and Deputy Program Directors are specified as a minimum of four years or a completion of a major milestone. The Air Force Systems Command has also taken steps to improve the quality of Program Directors and Program Managers. First, a career development program was implemented in July 1986 requiring certification of individuals based upon minimum levels of education and experience. Second, in December 1987, Air Force Systems Command began an effort to identify key program office positions requiring the most qualified individuals. Individuals assigned to these key positions must have been certified through the career development program. Finally, the Air Force Systems Command is in the process of revising the list of key positions and has received ESD's input. This input requested that all five program managers, and the Chief Engineers of the Space Defense Operations Center, the Survivable Communications Integration System, and the Communications System Segment Replacement be identified as key positions.

- **FINDING J: Deferring Critical Decisions Diffuses Accountability.** The GAO reported that the projects it reviewed demonstrated a pattern of deferring, rather than solving, problems occurring during system development. The GAO observed that, for more than 3 years, the Air Force deferred resolving fundamental technical problems in the Space Defense Operation Center program to subsequent program phases, and ultimately developed a subsystem that could not deliver its required operational capability. The GAO concluded that, in the aggregate, this environment of dispersed responsibilities, multiple reassignment of managers, and deferring rather than resolving problems has diluted accountability for development and integration and has jeopardized program success. The GAO reported that, in

Now on pp. 4-5 and pp. 28-30.

the Tactical Warning and Attack Assessment subsystem management environment, where authority and responsibility are diffused and management continuity has not been maintained, the practice of deferring problems to later years of the program rather than solving them when they arise, further dilutes or eliminates accountability. The GAO found, for example, that portions of both the Space Defense Operations Center and the Communications System Segment Replacement programs have been accepted by the Air Force, although they cost more than originally estimated and do not satisfy original specifications. The GAO questioned whether these programs can successfully fulfill their specified mission functions. In summary, the GAO concluded that specific accountability for problems deferred throughout systems development cannot be readily assigned. (pp. 40-44/GAO Draft Report)

DoD RESPONSE: Partially concur. The DoD disagrees that specific accountability has not been assigned. Program development responsibilities have been assigned by the Program Management Directives and have been most recently updated in Program Management Directive 1044(4). Recognizing that some decisions may not have been made promptly, increased management oversight by the System Executive Manager has been initiated. The System Executive Manager completed a review of the five acquisition programs on March 29, 1989, and will be conducting quarterly reviews of the Cheyenne Mountain programs, starting in July 1989, to ensure timely decisions are made and implemented.

- **FINDING K: Fundamental Technical Problems with SPADOC Remain After Years Of Development.** The GAO reported that the Air Force acquisition of the Space Defense Operations Center provides a case study of what happens when managers allow a program to continue without resolving system weaknesses and identified problems. The GAO reported that, as early as August 1983, the Mitre Corporation, the Electronic Systems Division engineering contractor responsible for monitoring the technical aspects of Space Defense Operations Center development, informed the Air Force that it was concerned about the adequacy of the Center performance prediction model, security design progress, and overall software design quality. The GAO noted that these concerns were confirmed when block A failed to satisfy most mission-related performance requirements during testing by the Air Force Operational Test and Evaluation Center in June 1987 and by the Air Force Systems Command during January and February 1988. The GAO reported that, although block A has not successfully completed any of the system performance tests attempted, in April 1988, the Air Force accepted the block A system and deferred meeting the performance requirements to block B, already in development. The GAO reported that the development of block B, which depends upon the block A hardware and software, began in June 1986, even though block A performance was not completed and the Air Force was aware of significant block A performance deficiencies that could seriously affect block B development. The GAO also reported that the Air Force did not agree to contractor proposed additional computing capability because it was unclear whether adding computing capability would be sufficient to achieve the required performance levels. The GAO noted that, subsequently (according to Mitre), similar problems to those which affected block A development occurred in block B. The GAO observed that, since February 1987, the Air Force and the contractor have been in a stalemate about how to best meet system

Now on p. 5 and pp. 30-31.

performance requirements. The GAO observed, however, that the contractor is continuing to design the block B system, even though it has not agreed with the Air Force on what hardware and/or software design changes are needed. The GAO concluded that the Air Force could, at any point in the acquisition process, have suspended development of the Space Defense Operations Center program until problems were addressed and resolved, but, instead, it repeatedly deferred them. The GAO further concluded that five years and four program managers later, the block A system, accepted by the Air force in April 1988, did not meet requirements and the Air Force again deferred resolution to the development of block B. The GAO also concluded that, while block B has been in development for over 2 years, the contractor system design is still unacceptable to the Air Force and the Air Force is again deferring resolution of block B design and development problems. (pp. 44-46/GAO Draft Report)

DoD RESPONSE: Partially Concur. Although Space Defense Operations Center 4 does not completely satisfy all operational requirements and specifications, it nonetheless provides a significant improvement over current capabilities. Formal suspension of Blocks A and B development was considered, but at no time did the Air Force (to include both Electronic Systems Division and Air Force Space Command), nor U.S. Space Command consider it to be in the best interest of the Government to do so. Such action would have resulted in a loss of trained contractor staff, thus increasing both costs, including contract termination charges, and risk while further delaying development. Various management actions have been recently taken by Air Force Space Command and the Electronic Systems Division that have resulted in improved performance by the contractor. The Space Defense Operations Center 4 Block A achieved initial operating capability in April 1989 and Block A remaining issues are expected to be resolved during the Block B critical design review, scheduled for May 1989. No performance requirements are being deferred to Block C.

- FINDING L: Air Force Accepted Communications Unit With Known Deficiencies. The GAO found that the development of a technical control unit for the Communications System Segment Replacement program (1) has experienced significant schedule delays and performance problems, (2) has had installation delayed from 1986 to 1990 and (3) after 5 years of development, cannot fully meet contract specifications. The GAO observed that, nonetheless, the Air Force accepted the unit in November 1988, without having either corrected technical deficiencies or conducted complete end-to-end testing. The GAO found that the Air Force intends to have the contractor correct the deficiencies during subsequent development of block II of the communications subsystem. The GAO also reported that the Air Force now maintains that the technical control unit, already delivered and accepted, cannot be installed until sometime in 1990. The GAO concluded that, even if technical deficiencies in the development effort were resolved, the technical control unit would still not work with other North American Air Defense System subsystems because the unit was designed to a wiring standard that is not compatible with equipment currently in the mountain. The GAO reported that the Air Force initially estimated that it will take about 18 months and up to \$5 million to resolve the wiring problem within Cheyenne Mountain, but has not resolved the problem or requested the funds to implement a solution. (pp. 47-48/GAO Draft Report)

Now on p. 32.

DoD RESPONSE: Partially concur. The Air Force has not accepted the communications unit as stated in the DoD response to the draft GAO report on Communications System Segment Replacement. There have been schedule delays, but the major one was caused by a two year delay in the contract award of the second block of work and the concurrent decision to install both blocks of the Communications System Segment Replacement program at the same time. The Air Force delayed the Block II initiation by two years in order to resolve dissatisfaction with the contractor's Block I work, reduce the cost of the Block II effort and explore competition of the Block II effort. The contractor is in the development phase for the communications unit and on schedule to test and install the communications unit in FY 1990 for an FY 1991 initial operating capability, as planned at the initiation of the Block II effort. The Air Force has actions underway, including initial removal of cables, to ensure the existing wiring in the Cheyenne Mountain Complex meets the wiring interfaces specified for the communications unit. The Air Force estimate of the time and money necessary to upgrade the Cheyenne Mountain Complex wiring has not changed. Although the effort is not complete, the Air Force has requested the funds.

* * * * *

RECOMMENDATIONS

- RECOMMENDATION 1: The GAO recommended that the Secretary of Defense restructure the roles and responsibilities of the key managers within the Tactical Warning and Attack Assessment executive management structure, designating a single manager, at a level below the Air Force Chief of Staff, with responsibility, authority, and accountability for the entire life cycle of the Tactical Warning and Attack Assessment System, from requirements through acquisition to operations and maintenance. (pp. 51/GAO Draft Report)

DoD RESPONSE: Partially concur. The Department of Defense does not agree that there should be a restructure of the total acquisition system. There is a single manager below the Air Force Chief of Staff with responsibility, authority and accountability for the Tactical Warning and Attack Assessment System, from requirements through acquisition oversight to operations and maintenance. That person is the Commander of Air Force Space Command in his role as the System Executive Manager. Joint Chiefs of Staff Memorandum 27-86 assigns the Executive Agent role to Air Force Chief of Staff and the Air Force has clearly assigned that responsibility to the Commander, Air Force Space Command, as the System Executive Manager in Program Management Directive 1044(4). The Air Force has provided the System Executive Manager with a staff of 91 people and an annual budget of approximately \$13 million, which is dedicated to ensuring technical integrity of the entire, end-to-end Tactical Warning and Attack Assessment System. The updated Program Management Directive further strengthened the System Executive Manager by more clearly defining his organization, his role and responsibilities, and by directing specific support from other major commands. Within 30 days, the Office of the Secretary of Defense will direct the Air Force to review the management structure to eliminate unnecessary duplicative working groups and streamline the organization. (See DoD Response to Finding B.) The Office of the Secretary of Defense will also assess the Air Force management structure as a part of the Summer 1989 review by the Defense Acquisition Board.

Now on p. 5 and p. 34.

- **RECOMMENDATION 2:** The GAO recommended that Secretary further ensure that the designated system manager has control over the necessary budgetary and management resources to carry out his responsibilities. (pp. 51/GAO Draft Report)

DoD RESPONSE: Concur. The DoD considers that the System Executive Manager already has designated control over necessary budgetary and management resources to carry out his responsibilities as specified in the Program Management Directive. The System Executive Manager, in his role as Commander, Air Force Space Command, programs the necessary budget for the acquisition programs and defends it through the budgetary process. The Commander-in-Chief, U.S. Space Command supports and participates in the budgetary process through his Integrated Priority List. In the November 1987 Integrated Priority List, The Commander-in-Chief, U.S. Space Command ranked these programs as his second highest priority to help support adequate funding for these acquisitions. In addition, the Senior Review Group was formed to help review problems and make decisions on the acquisition programs when general officer involvement is required. As stated earlier, within the next 30 days, the Office of the Secretary of Defense will direct the Air Force to evaluate the effectiveness of the Senior Review Group and the working groups and report the results within six months (see DoD Responses to Findings B and E).

- **RECOMMENDATION 3:** The GAO recommended that the Secretary direct the designated system manager to revalidate system requirements with the user for each of the modernization programs. (pp. 52/GAO Draft Report)

DoD RESPONSE: Partially concur. Requirements were revalidated as part of the program baselines published on December 1, 1987. New requirements and changed user requirements are worked through the existing structure until validation by appropriate authority. In addition, these programs are reviewed on a continuing basis during the normal management process. The Senior Review Group was created to help assess proposed changes or problem solutions, to ensure they are valid and should be implemented in the acquisition programs.

An Acquisition Program Baseline is being developed to support the executive reporting requirements. The Acquisition Program Baseline includes the required technical characteristics for the individual programs and will eventually include overall, end-to-end Cheyenne Mountain Upgrade technical characteristics. It also includes cost and schedule requirements. As part of the baseline approval cycle, coordination between the Air Force Space Command and the Air Force Systems Command is required and will form a "contract," which will identify specifically (1) what will be developed, (2) how much it will cost, and (3) when it will be delivered. Any known new requirement will be addressed in the development of the overall baseline. Failure to meet any of these areas requires immediate elevation to the Acquisition Executive for resolution. The Acquisition Program Baseline completion is required within 45 days of the updated Cheyenne Mountain Upgrade Program Management Directive, which is expected to be published by May 1989.

- **RECOMMENDATION 4:** The GAO recommended that the Secretary direct the system manager to include the following in the congressionally-mandated Defense Acquisition Board management review:
 - the actions and timetable for resolving known system integration problems;
 - the mechanism the manager intends to employ to improve continuity in program management; and
 - the actions to identify and resolve future integration problems in a timely fashion. (pp. 52/GAO Draft Report)

Now on p. 5 and p. 34.

DoD RESPONSE: Concur. The DoD already has received congressional direction for the Defense Acquisition Board Review of the Cheyenne Mountain programs. The DoD intends to completely fulfill that direction and report the results to Congress. Increased emphasis has been placed on overall system integration efforts to resolve future integration problems in a timely fashion, and as a result the Acquisition Integration Office was established in April 1987 at Headquarters Electronic Systems Division. It is the systems engineer responsible for identifying integration issues between the ongoing programs and for the development and tracking of plans to resolve the issues.

System integration problems are worked on a daily basis with an ongoing effort to completely identify all work required. In October 1988, three government staff, five MITRE Corporation technical staff, and two contractor staff were added to the Acquisition Integration Office to assist in the resolution of disconnects; as a result, disconnect closure has been exceeding problem identification since October 1988. In addition, in January 1989, Electronic Systems Division implemented a management process (called the Program Planning Management System) to track via computers all integration problems to resolution.

To improve continuity in program management, the Air Force Systems Command has taken many actions, including stabilized tours, to reduce management turnover and these actions are continuing today. (See the DoD Response to Finding I.)

All of these items and actions will be addressed in depth in the Defense Acquisition Board review.

Major Contributors to This Report

**Information
Management and
Technology Division,
Washington, D.C.**

Samuel W. Bowlin, Director, Defense and Security Information Systems,
(202) 275-4649
Melroy D. Quasney, Chief Technical Adviser
Gregory J. McDonald, Assistant Director
Michael T. Blair, Assistant Director
Joseph E. Malloy, Evaluator-in-Charge
M. Rose Hernandez, Evaluator

**Denver Regional
Office**

Sigrid L. McGinty, Evaluator

Boston Regional Office

Charles J. Appel, Evaluator